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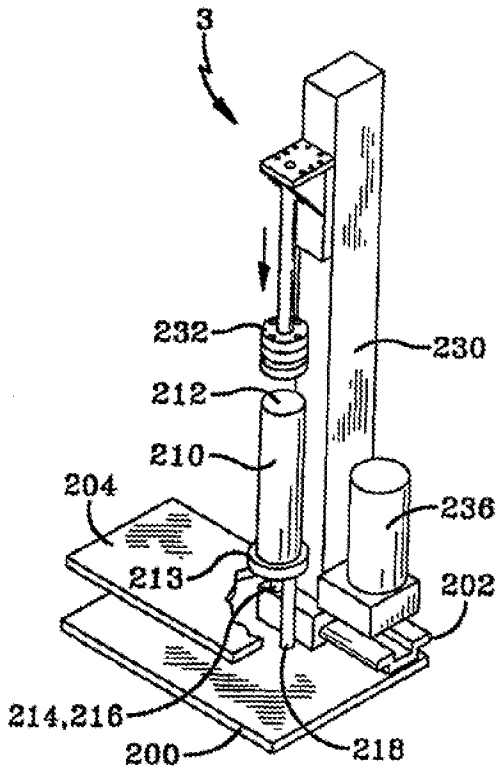
(57) Abstract

The invention is a mechanism (3) for automated handling of chemical containment cartridges (1, 2) and dispensing the chemicals contained within the cartridges (1, 2) to molding systems, and in particular, rapid injection molding systems. The embodiments of the invention are capable of handling and dispensing chemicals from a single cartridge (1, 2) or up to eight cartridges (1, 2) in an automated fashion. The mechanism (3) handles and dispenses chemicals in a manner that protects them from moisture and airborne contamination. The mechanism (3) incorporates a novel means for preventing use of improper chemicals in a dispensing mechanism (3) through the use of mechanical interlocks (180, 182, 184, 186, 188), thus preventing system damage through the use of improper chemicals. The mechanism (3) also includes a means for reading a tagging device (170) on a cartridge that contains chemical manufacture information for quality control purposes, and for preventing use of chemicals that have exceeded the shelf life of the chemical. The mechanism (3) includes a programmable controller (400) automatically controlling the sensors and actuators (330, 370) that are components of the mechanism (3).



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CHEMICAL CARTRIDGE HANDLING AND DISPENSING MECHANISM

Background

The invention relates generally to apparatus for handling and dispensing chemical components. More particularly, the invention relates to a cartridge for containing chemical components and a mechanism for automated handling of the cartridges and for dispensing the chemical components from the cartridges. It is particularly suitable for use in systems for rapid injection molding fragile pieces such as electronic devices.

Conventional encapsulation methods for fragile pieces such as electronic devices commonly use epoxy transfer molding techniques. These techniques generally use thermosetting epoxy components that are premixed at the factory and supplied to the end user in pill form, while being maintained at a low temperature or "frozen" molecular state to retard premature chemical reaction. When used, these thermosetting pills are allowed to reach room temperature and fed into a molding machine, where devices are encapsulated by the thermosetting epoxy. These thermosetting pills are often preheated using high frequency electromagnetic radiation prior to being fed into the molding machine. The encapsulated devices must then be placed in ovens for several hours to enable the thermosetting epoxy to cure. United States Patent No.5,098,626 describes a method for packing and dispensing thermosetting resin for encapsulation purposes. Some of the disadvantages of conventional encapsulation methods include the need to refrigerate the chemical components until ready for use, slow mold cycle times and long curing times, and high temperature and pressure associated with the molding process which sometimes result in premature device failure.

High pressure rapid injection molding techniques have been used for molding relatively large components, such as automobile parts. United States Patent No. 4,795,336 and No. 5,562,883 describe high pressure rapid injection molding systems. These techniques have been unsuitable for small fragile components because of the relatively high pressures and velocities involved. These techniques require handling of chemical components when filling large

chemical holding tanks, usually from drums containing the chemical components. The personnel who perform this operation must be specially trained in handling the chemical components. When in operation, systems using these techniques generally use high pressure metering pumps for dispensing the chemical components from the chemical holding tanks. Some of the disadvantages of existing rapid injection molding techniques is that they are not suitable for encapsulating small fragile devices, and that they require trained personnel to handle the chemical components.

New low pressure rapid injection molding systems have been developed that are suitable for encapsulating small fragile parts. One such system is described in United States Patent Application No. 09/036,737. There is a need for a chemical containment device or cartridge, and a compatible chemical handling and dispensing mechanism that is compatible with the new low pressure rapid injection molding systems and that does not require specially trained personnel for chemical handling. It is desirable that the chemical handling and dispensing mechanism be capable of automatically and continuously dispensing chemical components in correctly metered proportions, even as one chemical cartridge is emptied and another is brought on-line. It is further desirable that the chemical handling and dispensing mechanism be capable of handling both a single cartridge or a plurality of cartridges without intervention by the operator for reloading. It is desirable that any preheating steps performed prior to inserting the chemicals into the handling and dispensing mechanism be eliminated. The mechanism must also be capable of providing an indication to the operator of a low supply of chemical. Since moisture and other contaminants in the air may have a deleterious effect on chemicals and the operation of a rapid injection molding system, it is also desirable that the chemical cartridge and the chemical handling and dispensing mechanism prevent undue exposure to atmospheric air. The chemical handling and dispensing mechanism must be easy to use and service by personnel who are not specially trained to handle chemicals. It is also desirable that the cartridge and mechanism have an interlock capability to prevent improper chemicals to be used in order to prevent system malfunction. Another requirement is a tagging capability to enable chemical manufacture information to be stored on the cartridge at time of

manufacture and subsequently read by the dispensing mechanism prior to dispensing the chemicals.

Summary

The present invention is directed to a device and mechanism that satisfies these needs. The present invention provides for a chemical containment cartridge and an automated cartridge handling and dispensing mechanism that is compatible with low pressure rapid injection molding systems suitable for encapsulating small fragile parts. The present invention is capable of containing and continuously dispensing chemicals in correctly metered proportions, even as one chemical containment cartridge is emptied and another is brought on-line. The chemical containment cartridge provides unique sealing capability to prevent moisture and airborne contamination of the chemical contained in the cartridge. No chemical preheating is required in the present invention. An interlocking capability is provided in order to prevent a malfunction from improper chemicals in the rapid injection molding systems. A tagging capability enables chemical manufacture information to be stored on the cartridge at time of manufacture and subsequently read by the dispensing mechanism prior to dispensing the chemicals. The cartridge handling and dispensing mechanism is capable of handling both a single chemical containment cartridge or a plurality of chemical containment cartridges without the requirement of being reloaded by the operator. When the mechanism is low on its available supply of chemical, it will provide a notification to an operator. Other conditions may also provide notification to an operator. The chemical handling and dispensing mechanism prevents undue exposure to atmospheric air that may cause contamination of the chemical components, and has the capability of preheating the chemicals prior to dispensing. It is easy to use and service by personnel who are not specially trained to handle chemicals.

A device having features of the present invention is a chemical handling and dispensing mechanism, comprising a means for loading a dispensing chamber with a chemical containment cartridge, a means for activating a dispensing piston, positioned on a dispensing actuator, for causing a chemical to be dispensed from the cartridge to a mixing mechanism, and a means for ejecting the cartridge from

the dispensing chamber when the cartridge is empty. The means for loading the dispensing chamber may comprise a slide mechanism affixed to the dispensing actuator, a slide actuator for displacing and repositioning the dispensing actuator over the dispensing chamber, and a loading aperture on the dispensing chamber for manual insertion of a cartridge into the dispensing chamber by an operator. The means for activating the dispensing piston may comprise the dispensing actuator for activating the dispensing piston, the dispensing piston for seating the cartridge, a piercing nozzle for piercing a seal in a nozzle of the cartridge, and a dispensing tube for dispensing the chemical to the mixing mechanism. The means for ejecting the empty cartridge may comprise the dispensing piston being withdrawn from the dispensing chamber, a slide mechanism affixed to the dispensing actuator, a slide actuator for displacing the dispensing piston of the dispensing actuator from over the dispensing chamber, and an ejection mechanism for ejecting the empty cartridge from the dispensing chamber into a disposal chute. The chemical handling and dispensing mechanism may further comprising a means for controlling the mechanism. The means for controlling the mechanism may be a programmable controller. The chemical handling and dispensing mechanism may further comprise a means for dispensing the chemical to a mixing mechanism in a controlled manner. The means for dispensing the chemicals in a controlled manner may be a linear controlled dispensing actuator.

A method having features of the present invention is a chemical handling and dispensing method comprising loading a dispensing chamber with a chemical containment cartridge, activating a dispensing piston positioned on a dispensing actuator causing a chemical to be dispensed from the cartridge to a mixing mechanism, and ejecting the cartridge from the dispensing chamber when the cartridge is empty.

A device having features of the present invention is a chemical handling and dispensing mechanism comprising a means for sequentially loading a transfer tube with a plurality of chemical containment cartridges, a means for transferring a first dispensing chamber cartridge from the transfer tube to a first dispensing chamber, a means for transferring a second dispensing chamber cartridge from the transfer tube to a second dispensing chamber, a means for activating a first dispensing

piston positioned on a first dispensing actuator causing a chemical to be dispensed from the first dispensing chamber cartridge to a mixing mechanism, a means for activating a second dispensing piston positioned on a second dispensing actuator causing a chemical to be dispensed from the second dispensing chamber cartridge to a mixing mechanism, a means for ejecting the first dispensing chamber cartridge from the first dispensing chamber when the first dispensing chamber cartridge is empty, and a means for ejecting the second dispensing chamber cartridge from the second dispensing chamber when the second dispensing chamber cartridge is empty. The means for sequentially loading the transfer tube may comprise a three position rotary actuator for positioning the transfer tube in a central operate position, and a gripping mechanism for holding chemical containment cartridges manually placed within the transfer tube by an operator. The means for transferring the first dispensing chamber cartridge may comprise a first slide mechanism affixed to the first dispensing actuator, a first slide actuator for displacing and repositioning the first dispensing actuator over the first dispensing chamber, a three position rotary actuator for positioning the transfer tube containing the first dispensing chamber cartridge over the first dispensing chamber, a first loading aperture on the first dispensing chamber for automatic insertion of a first dispensing chamber cartridge by the transfer tube, and a gripping mechanism for releasing a first dispensing chamber cartridge from the transfer tube into the first dispensing chamber. The means for transferring the second dispensing chamber cartridge may comprise a second slide mechanism affixed to the second dispensing actuator, a second slide actuator for displacing and repositioning the second dispensing actuator over the second dispensing chamber, a three position rotary actuator for positioning the transfer tube containing the second dispensing chamber cartridge over the second dispensing chamber, a second loading aperture on the second dispensing chamber for automatic insertion of a second dispensing chamber cartridge by the transfer tube, and a gripping mechanism for releasing a second dispensing chamber cartridge from the transfer tube into the second dispensing chamber. The means for activating the first dispensing piston may comprise the first dispensing actuator for activating the first dispensing piston, the first dispensing piston for seating the first dispensing chamber cartridge, a first

piercing nozzle for piercing a seal in a nozzle of the first dispensing chamber cartridge, and a first dispensing tube for dispensing the chemical to the mixing mechanism. The means for activating the second dispensing piston may comprise the second dispensing actuator for activating the second dispensing piston, the second dispensing piston for seating the second dispensing chamber cartridge, a second piercing nozzle for piercing a seal in a nozzle of the second dispensing chamber cartridge, and a second dispensing tube for dispensing the chemical to the mixing mechanism. The means for ejecting the first dispensing chamber cartridge may comprise the first dispensing piston being withdrawn from the first dispensing chamber, a first slide mechanism affixed to the first dispensing actuator, a first slide actuator for displacing the first dispensing piston positioned on the first dispensing actuator, from over the first dispensing chamber, and a first ejection mechanism for ejecting empty first dispensing chamber cartridges from the first dispensing chamber into a first disposal chute. The means for ejecting the second dispensing chamber cartridge may comprise the second dispensing piston being withdrawn from the second dispensing chamber, a second slide mechanism affixed to the second dispensing actuator, a second slide actuator for displacing the second dispensing piston positioned on the second dispensing actuator, from over the second dispensing chamber, and a second ejection mechanism for ejecting empty second dispensing chamber cartridges from the second dispensing chamber into a second disposal chute. The means for activating the first dispensing piston may further comprise a first mechanical interlock located at a lower extremity of the first dispensing chamber for inhibiting dispensing of chemicals if the first mechanical interlock does not mate with a first corresponding mechanical interlock on the first dispensing chamber cartridge. The means for activating the second dispensing piston may further comprise a second mechanical interlock located at a lower extremity of the second dispensing chamber for inhibiting dispensing of chemicals if the second mechanical interlock does not mate with a second corresponding mechanical interlock on the second dispensing chamber cartridge. The means for transferring the first dispensing chamber cartridge may further comprise heating coils encircling the first dispensing chamber for preheating a chemical in the first dispensing chamber cartridge. The means for

transferring the second dispensing chamber cartridge may further comprise heating coils encircling the second dispensing chamber for preheating a chemical in the second dispensing chamber cartridge. The chemical handling and dispensing mechanism may further comprise a means for forcing a chemical through the mixing mechanism and preloading the first and second dispensing tubes by activating the first and second dispensing pistons. The chemical handling and dispensing mechanism may further comprise a means for sending a warning alert to an operator if the operator fails to reload the transfer tube within a first predetermined time interval. The chemical handling and dispensing mechanism may further comprise a means for shutting down the dispensing mechanism if the first and second dispensing chambers are empty and the transfer tube has not been reloaded. The means for activating the first dispensing piston may further comprise a first load cell positioned on the first dispensing piston for providing a signal to a controller to enable dispensing a chemical from the first dispensing chamber cartridge to the mixing mechanism at a controlled rate. The first dispensing tube may comprise a feed tube enclosed by a heated jacket for maintaining the chemical in the feed tube at an elevated temperature. The means for activating the second dispensing piston may further comprise a second load cell positioned on the second dispensing piston for providing a signal to a controller to enable dispensing a chemical from the second dispensing chamber cartridge to the mixing mechanism at a controlled rate. The second dispensing tube may comprise a feed tube enclosed by a heated jacket for maintaining the chemical in the feed tube at an elevated temperature. The means for sequentially loading the transfer tube with a plurality of chemical containment cartridges may comprise a rotary positioning table having a plurality of cartridge storage silos, each silo having an aperture at an upper extremity for loading chemical containment cartridges by an operator, an indexing drive mechanism connected to the rotary positioning table for sequentially positioning each silo under the transfer tube, and a loading actuator located below the silo that is positioned beneath the transfer tube for pushing a cartridge up through the silo aperture into the transfer tube where it is held by a gripping mechanism. The means for sequentially loading the transfer tube with a plurality of chemical containment cartridges may further comprise a mechanical

interlock located at a lower extremity of each silo for inhibiting operation of the handling and dispensing mechanism if the mechanical interlock does not mate with a corresponding mechanical interlock on a cartridge in the silo. The means for sequentially loading the transfer tube with a plurality of chemical containment cartridges may further comprise a means for reading tagging information and electronic interlock information on the chemical cartridges in the silos. The means for reading tagging information and electronic interlock information may be selected from the group consisting of a bar code reader, a magnetic strip reader, a magnetic pin reader, and an ASIC chip reader. The chemical handling and dispensing mechanism may further comprise a means for controlling the mechanism. The means for controlling the mechanism may be a programmable controller.

A method having features of the present invention is a chemical handling and dispensing method comprising sequentially loading a transfer tube with a plurality of chemical containment cartridges, transferring a first dispensing chamber cartridge from the transfer tube to a first dispensing chamber, transferring a second dispensing chamber cartridge from the transfer tube to a second dispensing chamber, activating a first dispensing piston positioned on a first dispensing actuator causing a chemical to be dispensed from the first dispensing chamber cartridge to a mixing mechanism, activating a second dispensing piston positioned on a second dispensing actuator causing a chemical to be dispensed from the second dispensing chamber cartridge to a mixing mechanism, ejecting the first dispensing chamber cartridge from the first dispensing chamber when the first dispensing chamber cartridge is empty, and ejecting the second dispensing chamber cartridge from the second dispensing chamber when the second dispensing chamber cartridge is empty. The chemical handling and dispensing method may further comprise forcing a chemical through the mixing mechanism and preloading the first and second dispensing tubes by activating the first and second dispensing pistons. The chemical handling and dispensing method may further comprise sending a warning alert to an operator if the operator fails to reload the transfer tube within a first predetermined time interval. The chemical handling and dispensing method may further comprise

shutting down the dispensing mechanism if the first and second dispensing chambers are empty and the transfer tube has not been reloaded.

A method having features of the present invention is a computer implemented method for controlling a cartridge handling and dispensing mechanism comprising initializing the mechanism, activating a first dispensing actuator to dispense a chemical from a first dispensing chamber cartridge in a first dispensing chamber at a controlled rate, emptying the first dispensing chamber cartridge, activating a second dispensing actuator to dispense a chemical from a second dispensing chamber cartridge in a second dispensing chamber at a controlled rate, ejecting the empty first dispensing chamber cartridge from the first dispensing chamber, loading a filled first dispensing chamber cartridge from a rotary positioning table into the first dispensing chamber, indexing the rotary positioning table, reading tagging information and electronic interlock information on a cartridge positioned beneath the transfer tube, emptying the second dispensing chamber cartridge, activating the first dispensing actuator to dispense a chemical from a first dispensing chamber cartridge in a first dispensing chamber at a controlled rate, ejecting the empty second dispensing chamber cartridge from the second dispensing chamber, loading a filled second dispensing chamber cartridge from the rotary positioning table into the second dispensing chamber, indexing a rotary positioning table, reading tagging information and electronic interlock information on a cartridge positioned beneath the transfer tube, emptying the first dispensing chamber cartridge, determining if an operator terminated operation of the handling and dispensing mechanism, determining if a supply of cartridges in the rotary positioning table is depleted, repeating the steps above if operation of the handling and dispensing mechanism is not terminated by an operator and the supply of cartridges in the rotary positioning table is not depleted, and terminating operation of the handling and dispensing mechanism if terminated by the operator or if the supply of cartridges in the rotary positioning table is depleted. The step of initializing the mechanism may comprise loading one or more chemical cartridges into the rotary positioning table, indexing the rotary positioning table, reading tagging information and electronic interlock information on a cartridge positioned beneath the transfer tube, loading a filled first dispensing chamber cartridge from

the rotary positioning table into the first dispensing chamber, indexing the rotary positioning table, reading tagging information and electronic interlock information on a cartridge positioned beneath the transfer tube, loading a filled second dispensing chamber cartridge from the rotary positioning table into the second dispensing chamber, indexing a rotary positioning table, reading tagging information and electronic interlock information on a cartridge positioned beneath the transfer tube, and purging a mixing system by activating the first and second dispensing actuators to fill a mixing mechanism with the chemical. The step of loading a dispensing chamber cartridge may comprise loading a transfer tube with a cartridge from the rotary positioning table, gripping the cartridge in the transfer tube, displacing the dispensing actuator from over the dispensing chamber, ejecting the empty dispensing chamber cartridge from the dispensing chamber, rotating the transfer tube to a position over the dispensing chamber, releasing the cartridge from the transfer tube into the dispensing chamber, rotating the transfer tube to a position over the rotary positioning table, and repositioning the dispensing actuator over the dispensing chamber. The step of determining if the supply of cartridges in the rotary positioning table is depleted may comprise determining if a number of cartridges available in the rotary positioning table is less than three after the rotary positioning table is indexed, initiating a first low chemical warning if the number of cartridges available in the rotary positioning table is equal to two after the rotary positioning table is indexed, initiating a second low chemical warning if the number of cartridges available in the rotary positioning table is equal to one after the rotary positioning table is indexed, and terminating operation of the mechanism if the number of cartridges available in the rotary positioning table is zero after the rotary positioning table is indexed, and the first and second dispensing chamber cartridges are empty.

Brief Description of the Drawings

These and other features, aspects, and advantages of the present invention will become better understood with regard to the following description, appended claims, and accompanying drawings where:

FIG-1A and FIG-1B show an embodiment of a chemical containment cartridge.

FIG-2A, FIG-2B, and FIG-2C show a preferred embodiment of a chemical containment cartridge.

FIG-3A through FIG-3E show chemical containment cartridges with mechanical interlocks and tagging means.

FIG-4A and FIG-4B show a manually loaded, single dispensing chamber embodiment of a chemical handling and dispensing mechanism.

FIG-5A, FIG-5B, and FIG-5C show an automatically loaded, dual dispensing chamber embodiment of a chemical handling and dispensing mechanism.

FIG-6A, FIG-6B, and FIG-6C show an automatically loaded, dual dispensing chamber embodiment of a chemical handling and dispensing mechanism with rotary storage capability.

FIG-7A and FIG-7B show a piercing nozzle and a dispensing tube.

FIG-8 shows a block diagram of the chemical handling and dispensing mechanism and associated controller.

FIG-9A and FIG-9B shows a flow chart of a controller program for controlling the operation of the chemical handling and dispensing mechanism.

FIG-10 shows a flow chart of a controller program for controlling the initialization of the chemical handling and dispensing mechanism.

FIG-11 shows a flow chart of a controller program for controlling the loading of a dispensing chamber with a cartridge.

FIG-12 shows a flow chart of a controller program for handling a low chemical condition during operation of the chemical handling and dispensing mechanism.

Detailed Description

Turning now to FIG-1A and FIG-1B, an embodiment of a chemical containment cartridge 1, is shown in accordance with the present inventive concepts in FIG-1A. The cartridge 1 comprises a tubular body 100, an activation end 110 and a dispensing end 120. Positioned at the dispensing end 120 is a cap 122 with a nozzle 130 affixed to it. The activation end 110 may be sealed with a

variety of end cap means, such as a deep drawn metal plunger, a polyethylene coated metal plunger, a crimped metal end cap with a seal to a polyethylene coated metal plunger, or a solid metal end cap with a "pull-tab" opening, crimped to the tubular body 100. The unique sealing capability of the chemical containment cartridge 1 is shown in FIG-1B. The tubular body 100 comprises a high density cardboard or high molecular weight polyethylene tube 102 covered on both inside and outside with aluminum foil 104. The aluminum foil 104 is covered with film of polyethylene 106 or similar material. A polyester adhesive is used as a bonding means between the polyethylene film 106 and the aluminum foil 104, and between the aluminum foil 104 and the cardboard tube 102. The inside layer of aluminum foil 104 and polyethylene film 106 may be replaced by an polyethylene coated aluminum foil bag liner 108. The dispensing end 120 has a metal cap 122 crimped to the tubular body 100. Affixed to the center of the metal cap 122 is the nozzle 130 of polyethylene or similar material. The end of the nozzle 130 shown in FIG-1B has been designed to mate with a complementary-shaped piercing nozzle of a chemical cartridge handling and dispensing mechanism. An aluminum foil burst seal 124 is adhesively attached over the inside aperture 126 of the nozzle 130.

Turning now to FIG-2A, FIG-2B, and FIG-2C, a preferred embodiment of a chemical containment cartridge 2, is shown in accordance with the present inventive concepts in FIG-2A. The device 2 comprises a tubular body 160 having an activation end 162, and a dispensing end 120. Positioned at the dispensing end 120 is a cap 122 with a nozzle 130 affixed to it. The dispensing end 120 is the same as the dispensing end 120 described in FIG-1A and FIG-1B. The cartridge 2 has an all metal sealed structure. The tubular body 160 is a one piece, deep drawn, very thin walled structure that is sealed and has no plunger or piston at the activation end 162. FIG-2B depicts a magnified section of the wall 164 of the tubular body 160. The wall 164 has pleated annular rings 166, 168 that are designed to collapse in an accordion fashion as the tubular body 160 is compressed at the activation end 162. This compression is normally performed by the chemical handling and dispensing mechanism. The all metal chemical containment cartridge 2 must be filled with a chemical before crimping the dispensing end 120 in place. It is hermetically sealed and provides a permanent

barrier to moisture. The unique sealing and tagging capability of the chemical containment cartridge 2 is shown in FIG-2C. The tubular body 160 is crimped to the dispensing end 120. The dispensing end 120 has a metal cap 122 crimped to the tubular body 100. Affixed to the center of the metal cap 122 is the nozzle 130 of polyethylene or similar material. The end of the nozzle 130 shown in FIG-2C has been designed to mate with a complementary-shaped piercing nozzle of a chemical cartridge handling and dispensing mechanism. An aluminum foil burst seal 124 is adhesively attached over the inside aperture 126 of the nozzle 130.

Turning now to FIG-3A through FIG-3E, further embodiments of the chemical containment cartridges 1, 2 described in FIG-1 and FIG-2 are shown. A cartridge handling and dispensing mechanism has means for mechanical interlocking and reading tagging information from each cartridge 2 as it is inserted into the mechanism. This tagging information could include data such as manufacturer lot numbers, manufacture date, and ship date that will be stored in the system and accessible by service personnel. This information is used for determining if chemicals have been stored past their shelf life as well as to provide traceability of the chemicals back to their original manufacture, for quality control purposes. There are several approaches that may be applied to the cartridge 2 and the cartridge handling mechanism. FIG-3A through FIG-3E depict a cartridge 2 having a tubular body 160 and a nozzle 130. Several variations of mechanical interlocks 180, 182, 184, 186, 188 are shown in FIG-3A through FIG-3E, respectively. There are many other possible interlock variations. A complimentary mating part of each mechanical interlocks 180, 182, 184, 186, 188 is positioned on the handling and dispensing mechanism. If the cartridge mechanical interlocks 180, 182, 184, 186, 188 do not mate with the complementary interlocks on the handling and dispensing mechanism, the dispensing operation is inhibited. The unique mechanical interlocks 180, 182, 184, 196, 188 are mounted on the end of the cartridge near the nozzle 130 to prevent use of non-approved cartridges. This feature prevents the use of improper materials in the system, as well as providing an indicator that the cartridge 2 is in position and seated properly. Another use of the mechanical interlocks 180, 182, 184, 186, 188 is to provide a housing for an intelligent material identification means for further system protection. Other

methods of providing electronic interlocking means and tagging information include a standard bar code label or a magnetic strip at a location 170 on the tubular body 160. Ferrite pins molded into the mechanical interlocks 180, 182, 184, 186, 188 could also be used to code the tagging information onto a cartridge 2. The electronic interlock would require that the dispensing mechanism read and determine that the tagging information is suitable to enable dispensing the chemicals without concern for system malfunction due to improper chemicals. The mechanical and electronic interlock means may both by implemented to complement one another. An application specific integrated circuit (ASIC) chip may also be embedded in the cartridge to provide tagging information and process control information that would allow the cartridge to reprogram system parameters unique to the material type or lot characteristics. The information provided in this manner would allow processing of mold conditioning or storage and transport of materials in an automated fashion without manual reprogramming or other operator intervention. The ASIC chip may also provide system protection to prevent variations in the material or cartridge that could result in reliability problems or severe damage to the system or system components. Power could be provided to the ASIC chip by printing a field coil on the cartridge to act as a transformer secondary, without the need for making electrical contact. Yet another technique that combines some of the described approaches is the use of an electronic "lot key." A "lot key" is an electronic module that plugs into the system to provide a unique authorization code that would recognize a particular lot code number or series of lot numbers for providing proper processing data for each material lot contained in the chemical cartridges. These modules are shipped with the material lot or lots it recognizes as authorized, and are recycled when the chemical material is consumed.

Turning to FIG-4A and FIG-4B, an embodiment of the chemical handling and dispensing mechanism 3 is shown in accordance with the present inventive concepts. FIG-4A and FIG-4B show a manually loaded, single dispensing chamber embodiment of a chemical handling and dispensing mechanism 3. FIG-4A shows the mechanism 3 in an operate position for dispensing a chemical from a chemical containment cartridge, and FIG-4B shows the mechanism 3 in a load position for

manually loading a chemical containment cartridge. The mechanism 3 comprises a tubular dispensing chamber 210 affixed on an upper mounting plate 204 at a mounting ring 213. The upper mounting plate 204 is positioned in a fixed relationship above a lower mounting plate 200. The dispensing chamber 210 has a loading aperture 212 at a top end for inserting a chemical containment cartridge and for accepting a dispensing piston 232 when in operational position. A dispensing tube 214 is located at a lower end of the dispensing chamber 210 for transferring a chemical in a cartridge within the dispensing chamber 210 to a mixing means. A piercing nozzle 216 is also located at the lower end of the dispensing chamber 210 at an entrance of the dispensing tube 214 for piercing a seal in a nozzle of a cartridge. An ejection mechanism 218, positioned between the lower mounting plate 200 and the upper mounting plate 204, is located at the lower end of the dispensing chamber 210 for ejecting empty cartridges from the dispensing chamber 210. A dispensing actuator 230 is affixed to a slide mechanism 202 that is affixed to the lower mounting plate 200 and is controlled by a slide actuator 236 for sliding the dispensing actuator 230 away from the dispensing chamber 210 to the load position as shown in FIG-4B, or over the dispensing tube 210 in the operate position as shown in FIG-4A. Under normal operation, the dispensing actuator 230 is positioned away from the dispensing chamber 210 as shown in FIG-4B to allow a cartridge to be inserted by an operator into the dispensing chamber 210 through the loading aperture 212. Prior to manual loading, a nozzle of the cartridge must be cut to length. The dispensing actuator 230 is then repositioned over the dispensing chamber 210 containing the cartridge, such that the dispensing piston 232 is directly over the activation end of the cartridge. The dispensing actuator 230 is then activated causing the dispensing piston 232 to drive down on the cartridge until it is seated, causing the piercing nozzle 216 to pierce a seal in the bottom of the cartridge. As the dispensing piston 232 continues to drive downward at a controlled rate, the chemical in the cartridge is caused to be dispensed through the dispensing tube 218 to a mixing mechanism. When the cartridge is empty, the dispensing piston 232 is withdrawn from the dispensing chamber 210, slide actuator 236 is activated to move the dispensing actuator 230 away from the dispensing chamber 210 as shown in

FIG-4B, and the ejection mechanism 218 is activated to eject the spent cartridge from the dispensing chamber 210 into a chute that conducts the empty to a disposal container. The mechanism is then ready to start another cycle.

Turning now to FIG-5A, FIG-5B, and FIG-5C, an embodiment of the chemical handling and dispensing mechanism 4 is shown in accordance with the present inventive concepts. FIG-5A, FIG-5B, and FIG-5C show an automatically loaded, dual dispensing chamber embodiment of a chemical handling and dispensing mechanism 4. FIG-5A shows the mechanism 4 in an operate position for dispensing a chemical from either one of two chemical containment cartridges in a first tubular dispensing chamber 310 and a second tubular dispensing chamber 350. FIG-5B shows the mechanism 4 in a first load position for automatically loading a chemical containment cartridge into the first dispensing chamber 310. The mechanism 4 comprises a tubular transfer tube 380 that is fixed to a three position rotary actuator 382 by a connecting rod 386. The connecting rod 386 is held in position by a connecting rod bearing 388 that is fixed to an upper mounting plate 304 that is positioned in a fixed relationship with a lower mounting plate 300. The rotary actuator 382 is affixed to the lower mounting plate 300 and can cause the transfer tube 380 to rotate in a counterclockwise direction 120 degrees from the operate position shown in FIG-5A to the first load position for positioning the transfer tube 380 over the first dispensing chamber 310, as shown in FIG-5B. Similarly, the rotary actuator 382 can also cause the transfer tube 380 to be rotated in a clockwise direction 120 degrees from the operate position shown in FIG-5A to a second load position for positioning the transfer tube 380 over the second dispensing chamber 350. A gripping mechanism 384 is fixed to the upper end of the connecting rod 386 and fits into slots on the transfer tube 380 for holding and releasing a cartridge placed in the transfer tube 380.

The first dispensing chamber 310 is affixed on the upper mounting plate 304 at a first mounting ring 313. The upper mounting plate 304 is positioned in a fixed relationship above a lower mounting plate 300. The first dispensing chamber 310 has a loading aperture 312 at a top end for insertion of a cartridge from the transfer tube 380 when in a first load position and for accepting a dispensing piston 332 when in operational position. A first dispensing tube 314 is located at a lower end

of the first dispensing chamber 310 for transferring a chemical in a cartridge within the first dispensing chamber 310 to a mixing means. A first piercing nozzle 316 is also located at the lower end of the first dispensing chamber 310 at an entrance of the first dispensing tube 314 for piercing a seal in a nozzle of a cartridge. Also located at the lower extremity of the first dispensing chamber 310 is a mechanical interlock 311 for mating with a corresponding mechanical interlock on a chemical containment cartridge. If the complementary cartridge mechanical interlock (180, 182, 184, 186, 188 in FIG-3) does not mate with the mechanical interlock 311, the dispensing operation is inhibited. A first ejection mechanism 318, positioned between the lower mounting plate 300 and the upper mounting plate 304, is located at the lower end of the first dispensing chamber 310 for ejecting empty cartridges from the first dispensing chamber 310. A chute is located to a side of the mechanism 4 nearest the first dispensing chamber 310, that collects the ejected cartridges and carries them to a disposal container. A first dispensing actuator 330 is affixed to a first slide mechanism 302 that is affixed to the lower mounting plate 300 and is controlled by a slide actuator 336 for sliding the first dispensing actuator 330 away from the first dispensing chamber 310 to the load position as shown in FIG-5B, or over the first dispensing tube 310 in the operate position as shown in FIG-5A. The first and second dispensing chambers 310, 380 may have the capability of preheating the chemical in the cartridge prior to dispensing. FIG-5C shows one embodiment of this capability applied to the first dispensing chamber 310, comprising heating coils 315 encircling the dispensing chamber 310 to which electric power is applied.

The second dispensing chamber 350 is affixed on the upper mounting plate 304 at a second mounting ring 353. The second dispensing chamber 350 has a loading aperture 352 at a top end for insertion of a cartridge from the transfer tube 380 when in a second load position and for accepting a second dispensing piston 372 when in operational position. Like the first dispensing chamber 310, the second dispensing chamber 350 has a second dispensing tube located at a lower end of the second dispensing chamber 350 for transferring a chemical in a cartridge within the second dispensing chamber 350 to a mixing means. Like the first piercing nozzle 316, a second piercing nozzle is located at the lower end of the

second dispensing chamber 350 at an entrance of the second dispensing tube for piercing a seal in a nozzle of a cartridge. Like the first dispensing chamber 310, located at the lower extremity of the second dispensing chamber 350 is a mechanical interlock for mating with a corresponding mechanical interlock on a chemical containment cartridge. If the complementary cartridge mechanical interlock (180, 182, 184, 186, 188 in FIG-3) does not mate with the dispensing chamber mechanical interlock, the dispensing operation is inhibited. Like the first ejection mechanism 318, a second ejection mechanism, positioned between the lower mounting plate 300 and the upper mounting plate 304, is located at the lower end of the second dispensing chamber 350 for ejecting empty cartridges from the second dispensing chamber 350. A chute is located to a side of the mechanism 4 nearest the second dispensing chamber 350, that collects the ejected cartridges and carries them to a disposal container. Like the first dispensing actuator 330, a second dispensing actuator 370 is affixed to a second slide mechanism, that is affixed to the lower mounting plate 300 and is controlled by a slide actuator, for sliding the second dispensing actuator 370 away from the second dispensing chamber 350 to a second load position, or over the second dispensing tube 350 in the operate position as shown in FIG-5A.

A normal operational cycle comprises an initialization sequence and a dispensing operation. The startup process begins with the manual placement by an operator, of a chemical containment cartridge in the transfer tube 380 that is held in place by the gripping mechanism 384. Prior to manual loading, a nozzle of the chemical containment cartridge must be cut to length. When the mechanism 4 senses the presence of a cartridge in the transfer tube 380, it activates the first slide actuator 336 to move the first dispensing actuator 330 away from the first dispensing chamber 310 to the first load position. The three position rotary actuator 382 is then activated to rotate the transfer tube 380 in a counterclockwise direction 120 degrees so that the cartridge in the transfer tube 380 is positioned over the loading aperture 312 of the first dispensing chamber 310, as shown in FIG-5B. The gripping mechanism 384 then releases the cartridge in the transfer tube 380 so that it drops into the first dispensing chamber 310. The rotary actuator 382 then is activated to rotate the transfer tube 380 clockwise 120 degrees back to a center

position, as shown in FIG-5A. The first slide actuator 336 is then activated to move the first dispensing actuator 330 to a position where the first dispensing piston 332 is centered over the loading aperture 312 of the first dispensing chamber 310, as shown in FIG-5A. This process is then repeated for the second dispensing chamber. An operator manually places a chemical containment cartridge in the transfer tube 380 that is held in place by the gripping mechanism 384. When the mechanism 4 senses the presence of a cartridge in the transfer tube 380 after loading the first dispensing chamber 310, it activates the second slide actuator to move the second dispensing actuator 370 away from the second dispensing chamber 350 to the second load position. The rotary actuator 382 is then activated to rotate the transfer tube 380 in a clockwise direction 120 degrees so that the cartridge in the transfer tube 380 is positioned over the loading aperture of the second dispensing chamber 350. The gripping mechanism 384 then releases the cartridge in the transfer tube 380 so that it drops into the second dispensing chamber 350. The rotary actuator 382 then is activated to rotate the transfer tube 380 counterclockwise 120 degrees back to a center position, as shown in FIG-5A. The second slide actuator is then activated to move the second dispensing actuator 370 to a position where the second dispensing piston 372 is centered over the loading aperture of the second dispensing chamber 350, as shown in FIG-5A. After both the first and second dispensing chambers 310, 350 have been loaded with a cartridge and the first and second dispensing actuators 330, 370 have been set to an operate position, the dispensing actuators 330, 370 are activated so that the first and second dispensing pistons 332, 372 begin to drive down the cartridges in the first and second dispensing chambers 310, 350 until they are seated. This seating process causes the seals in the bottoms of the cartridges to be pierced by the first and second piercing nozzles. The first and second dispensing actuators 330, 370 continue to activate to purge the system by forcing a chemical through a mixing means, flushing the system of any contaminants and preloading the first and second dispensing tubes with fresh chemical. The normal dispensing operation is then begun by activating only the first dispensing actuator 330 at a rate required by the system. The operator also manually places another cartridge in the transfer tube 380. The mechanism detects when the cartridge in the first

dispensing chamber 310 is empty and activates the second dispensing actuator 370 to supply chemical to the system from the second dispensing chamber 350. The first dispensing piston 332 is withdrawn from the first dispensing chamber 310, slide actuator 336 is activated to move the dispensing actuator 330 away from the dispensing chamber 310 as shown in FIG-5B, and the ejection mechanism 318 is activated to eject the empty cartridge from the dispensing chamber 310 into a chute located on a side of the mechanism 4 nearest the first dispensing chamber 310 for collecting the ejected cartridges in a disposal container. The first dispensing chamber 310 is the loaded as described above, so the a full cartridge is available when the cartridge in the second dispensing chamber 350 is empty. The process of reloading the second dispensing chamber 350 is repeated as describes above. If an operator fails to manually reload the transfer tube 380 within a first predetermined time interval, an warning alert will be sent to the operator. Failure to reload the transfer tube by the time that both cartridges in the first and second dispensing chambers 310, 350 are empty will result in a shutdown of the system. During normal operation, one dispensing actuator will be pressing a chemical into a mixing means at a controlled rate. This rate will be determined by feedback from a controller as well as a load cell positioned in the dispensing pistons 332, 372.

Turning now to FIG-6A, FIG-6B, and FIG-6C, a preferred embodiment of the chemical handling and dispensing mechanism 5 is shown in accordance with the present inventive concepts. FIG-6A, FIG-6B, and FIG-6C show an automatically loaded, dual dispensing chamber embodiment of a chemical handling and dispensing mechanism 5 having rotary storage capability. FIG-6A shows the mechanism 5 in an operate position for dispensing a chemical from either one of two chemical containment cartridges in a first tubular dispensing chamber 310 and a second tubular dispensing chamber 350. FIG-6B shows the mechanism 5 in a first load position for automatically loading a cartridge into the first dispensing chamber 310. FIG-6C shows a side view of the mechanism 5 in an operate position. The structure and operation FIG-6A, FIG-6B and FIG-6C is identical to that of FIG-5A and FIG-5B, respectively, except that FIG-6A, FIG-6B, and FIG-6C also show an eight position rotary positioning table 390 that automatically loads up to eight cartridges into the transfer tube 380. In addition to the components shown

and describe in FIG-5A and FIG-5B, FIG-6A, FIG-6B, and FIG-6C comprise the rotary positioning table 390 having eight tubular storage silos 394 for eight cartridges. Each silo 394 has an open aperture 392 at the upper extremity where a cartridge may be manually loaded by an operator. At the lower extremity of each silo is a mechanical interlock 309, as shown in FIG-6C, for mating with a corresponding mechanical interlock on a chemical containment cartridge. If the complementary cartridge mechanical interlock (180, 182, 184, 186, 188 in FIG-3) does not mate with the mechanical interlock 309, the dispensing operation is inhibited. Prior to manual loading, a nozzle of the cartridges must be cut to length. The aperture 392 of each silo 394 is sequentially positioned under the transfer tube 380, where a load actuator 398 located between the upper mounting plate 304 and the lower mounting plate 300 pushes a cartridge up into the transfer tube 380 where it is held by the gripping mechanism 384. The operation of the transfer tube 380, the rotary actuator 382, the first and second dispensing actuators 330, 370, and the first and second dispensing pistons 332, 372 is the same as described in FIG-5A and FIG-5B. When a silo 394 has been emptied, an indexing drive mechanism 396 rotates the rotary positioning table 390 so that another cartridge is available for loading into the transfer tube 380. In this manner, a mixing system employing the chemical handling and dispensing mechanism 5 may operate for an extended period of time without operator intervention. A means for reading tagging information and electronic interlock information 308 on the chemical cartridges is provided between the upper mounting plate 304 and the lower mounting plate 300. This reading means 308 may be a bar code reader, a magnetic strip reader, a magnetic pin reader, or an ASIC chip reader. If the information read from the chemical cartridge does not match data stored in a handling and dispensing mechanism controller, dispensing of the chemical in the cartridge is inhibited.

Turning to FIG-7A and FIG-7B, FIG-7A shows the first dispensing chamber 310 affixed to a mounting plate 303. The first dispensing chamber 310 has a loading aperture 312 at a top end for insertion of a chemical cartridge. A first dispensing tube 314 is located at a lower end of the first dispensing chamber 310 for transferring a chemical in a cartridge within the first dispensing chamber 310 to a mixing means. A first piercing nozzle 316 is also located at the lower end of the

first dispensing chamber 310 at an entrance of the first dispensing tube 314 for piercing a seal in a nozzle of a chemical cartridge. FIG-7B show a detailed view of the piercing nozzle 316 and the dispensing tube 314. The first dispensing tube 314 may comprise a feed tube 315 enclosed by a heated jacket 317 for maintaining the chemical within the feed tube 315 at an elevated temperature.

Turning to FIG-8, FIG-8 shows a block diagram 6 of the primary parts of the chemical handling and dispensing mechanism in relation to a controller 400 that controls the operation of the mechanism shown in FIG-5. FIG-8 depicts the controller 400 connected to the rotary positioning table 390, the transfer tube 380, the first and second dispensing actuators 330, 370, and the first and second dispensing chambers 310, 350. The controller 400 contains control programs for activating the actuators, and for reading sensor signals from load cells and positioning devices in the chemical handling and dispensing mechanism 5 shown in FIG-5.

Turning now to FIG-9A and FIG-9B, FIG-9A and FIG-9B shows a flow chart of a controller program sequence 7 for controlling the operation of the chemical handling and dispensing mechanism. The first step in the handling and dispensing operation is to initialize the mechanism 500. The first dispensing actuator is then activated 510 to dispense a chemical at a controlled rate to a mixing means in a mixing system. When the cartridge in the first dispensing chamber is empty 520, the second dispensing actuator is activated 530 to dispense a chemical at a controlled rate to the mixing means in the mixing system. The empty cartridge in the first dispensing chamber is ejected 540 and the first dispensing chamber is reloaded 550 with a cartridge filled with a chemical. The rotary positioning table is then indexed 560 and the cartridge tagging information and electronic interlock information is read 570 from the cartridge positioned beneath the transfer tube. When the cartridge in the second dispensing chamber is empty 580, the first dispensing actuator is activated 590 to dispense a chemical at a controlled rate to the mixing means in the mixing system. The empty cartridge in the second dispensing chamber is ejected 600 and the second dispensing chamber is reloaded 610 with a filled cartridge. The rotary positioning table is then indexed 620 and the cartridge tagging information and electronic interlock information is read

630 from the cartridge positioned beneath the transfer tube. When the cartridge in the first dispensing chamber is empty 640, the second dispensing actuator is activated 530, and the operation of steps 530 through 640 is repeated unless terminated by the operator 650 or when the chemical cartridge supply in the mixing and dispensing mechanism has been depleted 660. The operation of the handling and dispensing mechanism is then terminated 670.

Turning to FIG-10, FIG-10 shows a flow chart of a controller program for controlling the initialization sequence 8 (500 in FIG-9A) of the chemical handling and dispensing mechanism operation. The first step is to manually load cartridges, with nozzle tips facing a downward direction, into the silos of the rotary positioning table by the operator 700. The rotary positioning table is then indexed 710 for loading the silo that had been positioned beneath the transfer tube. A tag reader then reads the cartridge tagging information and electronic interlock information 720 on the cartridge positioned beneath the transfer tube. This information may include information such as lot numbers, chemical manufacture date, and ship date from the manufacturer to determine shelf life and provide traceability of the chemicals to original production for controlling quality of the finished product. If the cartridge tagging information and electronic interlock information matches data stored in the controller (400 in FIG-8), dispensing is enabled from that cartridge. The first dispensing chamber is then loaded 730 with a filled first dispensing chamber cartridge. The rotary positioning table is then indexed 740 and the tagging information and electronic interlock information is read 750 from the cartridge positioned beneath the transfer tube. If the cartridge tagging information and electronic interlock information matches the data stored in the controller, the second dispensing chamber is then loaded 760 with a filled second dispensing chamber cartridge. The rotary positioning table is indexed 770 and the next cartridge tag is read 780, as described above. The dispensing actuators are then activated to purge the mixing system 790, removing contaminants and filling the system with fresh chemical.

Turning now to FIG-11, FIG-11 shows a flow chart of a controller program for controlling the loading sequence 9 for loading a dispensing chamber with a cartridge. This loading sequence is generic in that it may be applied to loading

either a first dispensing chamber or a second dispensing chamber. The first step of the sequence 9 is to load the transfer tube with a cartridge from the rotary positioning table 800. A gripping mechanism on the transfer tube then grips the cartridge 810 to prevent it from falling out of the transfer tube. The dispensing actuator is then displaced 820 to a load position away from the dispensing chamber. If there is an empty cartridge in the dispensing chamber, it is ejected 830. The transfer tube containing a filled chemical cartridge is then rotated to the load position over the dispensing chamber 840. The cartridge in the transfer tube is released from the transfer tube gripping mechanism 850 and allowed to drop into the dispensing chamber. The transfer tube is then rotated to the operate position over the rotary positioning table 860. The dispensing actuator is then repositioned 870 to the operate position over the dispensing chamber.

Turning now to FIG-12, FIG-12 shows a flow chart of a controller program sequence 10 for handling a low chemical condition during the operation of the chemical handling and dispensing mechanism. After the rotary positioning table is indexed 900, the silos in the rotary table are checked by position sensors to determine if they are occupied or empty. If there are not less than three cartridges in the next three positions after an indexing step of the rotary positioning table 910, the programmed sequence awaits for the next indexing step of the rotary positioning table 900. If there are less than three cartridges in the next three positions 910 after an indexing operation, but there are two cartridges in the next two positions 920, a first low chemical alarm is initiated 930 to notify the operator. If there is not two cartridges in the next two positions 920 after an indexing operation, but there is one cartridge in the next position 940, a second low chemical alarm is initiated 950 to notify the operator. If there is not one cartridge in the next position 940 after an indexing operation, there are no more cartridges available 960, and the operations of the handling and dispensing mechanism and the mixing system are shut down when the cartridges in the first and second dispensing chambers are empty 970.

Although the present invention has been described in considerable detail with reference to certain preferred embodiments thereof, other embodiments are

possible. Therefore, the spirit and scope of the appended claims should not be limited to the description of the preferred embodiments herein.

WHAT IS CLAIMED IS:

1. A chemical handling and dispensing mechanism, comprising:

(a) a means for loading a dispensing chamber with a chemical containment cartridge;

(b) a means for activating a dispensing piston, positioned on a dispensing actuator, for causing a chemical to be dispensed from the cartridge to a mixing mechanism; and

(c) a means for ejecting the cartridge from the dispensing chamber when the cartridge is empty.

2. A chemical handling and dispensing mechanism according to claim 1, wherein the means for loading the dispensing chamber comprises:

(a) a slide mechanism affixed to the dispensing actuator;

(b) a slide actuator for displacing and repositioning the dispensing actuator over the dispensing chamber; and

(c) a loading aperture on the dispensing chamber for manual insertion of a cartridge into the dispensing chamber by an operator.

3. A chemical handling and dispensing mechanism according to claim 1, wherein the means for activating the dispensing piston comprises:

(a) the dispensing actuator for activating the dispensing piston;

(b) the dispensing piston for seating the cartridge;

(c) a piercing nozzle for piercing a seal in a nozzle of the cartridge; and

(d) a dispensing tube for dispensing the chemical to the mixing mechanism.

4. A chemical handling and dispensing mechanism according to claim 1, wherein the means for ejecting the empty cartridge comprises:

(a) the dispensing piston being withdrawn from the dispensing chamber;

(b) a slide mechanism affixed to the dispensing actuator;

(c) a slide actuator for displacing the dispensing piston of the dispensing actuator from over the dispensing chamber; and

(d) an ejection mechanism for ejecting the empty cartridge from the dispensing chamber into a disposal chute.

5. A chemical handling and dispensing mechanism according to claim 1, further comprising a means for controlling the mechanism.

6. A chemical handling and dispensing mechanism according to claim 5, wherein the means for controlling the mechanism is a programmable controller.

7. A chemical handling and dispensing mechanism according to claim 1, further comprising a means for dispensing the chemical to a mixing mechanism in a controlled manner.

8. A chemical handling and dispensing mechanism according to claim 7, wherein the means for dispensing the chemicals in a controlled manner is a linear controlled dispensing actuator.

9. A chemical handling and dispensing method, comprising:

(a) loading a dispensing chamber with a chemical containment cartridge;

(b) activating a dispensing piston positioned on a dispensing actuator causing a chemical to be dispensed from the cartridge to a mixing mechanism; and

(c) ejecting the cartridge from the dispensing chamber when the cartridge is empty.

10. A chemical cartridge handling and dispensing mechanism, comprising:

(a) a means for sequentially loading a transfer tube with a plurality of chemical containment cartridges;

(b) a means for transferring a first dispensing chamber cartridge from the transfer tube to a first dispensing chamber;

(c) a means for transferring a second dispensing chamber cartridge from the transfer tube to a second dispensing chamber;

(d) a means for activating a first dispensing piston positioned on a first dispensing actuator causing a chemical to be dispensed from the first dispensing chamber cartridge to a mixing mechanism;

(e) a means for activating a second dispensing piston positioned on a second dispensing actuator causing a chemical to be dispensed from the second dispensing chamber cartridge to a mixing mechanism;

(f) a means for ejecting the first dispensing chamber cartridge from the first dispensing chamber when the first dispensing chamber cartridge is empty; and

(g) a means for ejecting the second dispensing chamber cartridge from the second dispensing chamber when the second dispensing chamber cartridge is empty.

11. A chemical handling and dispensing mechanism according to claim 10, wherein the means for sequentially loading the transfer tube comprises:

(a) a three position rotary actuator for positioning the transfer tube in a central operate position; and

(b) a gripping mechanism for holding chemical containment cartridges manually placed within the transfer tube by an operator.

12. A chemical handling and dispensing mechanism according to claim 10, wherein the means for transferring the first dispensing chamber cartridge comprises:

(a) a first slide mechanism affixed to the first dispensing actuator;

(b) a first slide actuator for displacing and repositioning the first dispensing actuator over the first dispensing chamber;

(c) a three position rotary actuator for positioning the transfer tube containing the first dispensing chamber cartridge over the first dispensing chamber;

(d) a first loading aperture on the first dispensing chamber for automatic insertion of a first dispensing chamber cartridge by the transfer tube; and

(e) a gripping mechanism for releasing a first dispensing chamber cartridge from the transfer tube into the first dispensing chamber.

13. A chemical handling and dispensing mechanism according to claim 10, wherein the means for transferring the second dispensing chamber cartridge comprises:

(a) a second slide mechanism affixed to the second dispensing actuator;

(b) a second slide actuator for displacing and repositioning the second dispensing actuator over the second dispensing chamber;

(c) a three position rotary actuator for positioning the transfer tube containing the second dispensing chamber cartridge over the second dispensing chamber;

(d) a second loading aperture on the second dispensing chamber for automatic insertion of a second dispensing chamber cartridge by the transfer tube; and

(e) a gripping mechanism for releasing a second dispensing chamber cartridge from the transfer tube into the second dispensing chamber.

14. A chemical handling and dispensing mechanism according to claim 10, wherein the means for activating the first dispensing piston comprises:

(a) the first dispensing actuator for activating the first dispensing piston;

(b) the first dispensing piston for seating the first dispensing chamber cartridge;

(c) a first piercing nozzle for piercing a seal in a nozzle of the first dispensing chamber cartridge; and

(d) a first dispensing tube for dispensing the chemical to the mixing mechanism.

15. A chemical handling and dispensing mechanism according to claim 10, wherein the means for activating the second dispensing piston comprises:

(a) the second dispensing actuator for activating the second dispensing piston;

(b) the second dispensing piston for seating the second dispensing chamber cartridge;

(c) a second piercing nozzle for piercing a seal in a nozzle of the second dispensing chamber cartridge; and

(d) a second dispensing tube for dispensing the chemical to the mixing mechanism.

16. A chemical handling and dispensing mechanism according to claim 10, wherein the means for ejecting the first dispensing chamber cartridge comprises:

(a) the first dispensing piston being withdrawn from the first dispensing chamber;

(b) a first slide mechanism affixed to the first dispensing actuator;

(c) a first slide actuator for displacing the first dispensing piston positioned on the first dispensing actuator, from over the first dispensing chamber; and

(d) a first ejection mechanism for ejecting empty first dispensing chamber cartridges from the first dispensing chamber into a first disposal chute.

17. A chemical handling and dispensing mechanism according to claim 10, wherein the means for ejecting the second dispensing chamber cartridge comprises:

(a) the second dispensing piston being withdrawn from the second dispensing chamber;

(b) a second slide mechanism affixed to the second dispensing actuator;

(c) a second slide actuator for displacing the second dispensing piston positioned on the second dispensing actuator, from over the second dispensing chamber; and

(d) a second ejection mechanism for ejecting empty second dispensing chamber cartridges from the second dispensing chamber into a second disposal chute.

18. A chemical handling and dispensing mechanism according to claim 14, further comprising a first mechanical interlock located at a lower extremity of the first dispensing chamber for inhibiting dispensing of chemicals if the first mechanical interlock does not mate with a first corresponding mechanical interlock on the first dispensing chamber cartridge.

19. A chemical handling and dispensing mechanism according to claim 15, further comprising a second mechanical interlock located at a lower extremity of the second dispensing chamber for inhibiting dispensing of chemicals if the second mechanical interlock does not mate with a second corresponding mechanical interlock on the second dispensing chamber cartridge.

20. A chemical handling and dispensing mechanism according to claim 12, further comprising heating coils encircling the first dispensing chamber for preheating a chemical in the first dispensing chamber cartridge.

21. A chemical handling and dispensing mechanism according to claim 13, further comprising heating coils encircling the second dispensing chamber for preheating a chemical in the second dispensing chamber cartridge.

22. A chemical handling and dispensing mechanism according to claim 10, further comprising a means for forcing a chemical through the mixing mechanism and preloading the first and second dispensing tubes by activating the first and second dispensing pistons.

23. A chemical handling and dispensing mechanism according to claim 10,

further comprising a means for sending a warning alert to an operator if the operator fails to reload the transfer tube within a first predetermined time interval.

24. A chemical handling and dispensing mechanism according to claim 10, further comprising a means for shutting down the dispensing mechanism if the first and second dispensing chambers are empty and the transfer tube has not been reloaded.

25. A chemical handling and dispensing mechanism according to claim 14, further comprising a first load cell positioned on the first dispensing piston for providing a signal to a controller to enable dispensing a chemical from the first dispensing chamber cartridge to the mixing mechanism at a controlled rate.

26. A chemical handling and dispensing mechanism according to claim 14, wherein the first dispensing tube comprises a feed tube enclosed by a heated jacket for maintaining the chemical in the feed tube at an elevated temperature.

27. A chemical handling and dispensing mechanism according to claim 15, further comprising a second load cell positioned on the second dispensing piston for providing a signal to a controller to enable dispensing a chemical from the second dispensing chamber cartridge to the mixing mechanism at a controlled rate.

28. A chemical handling and dispensing mechanism according to claim 15, wherein the second dispensing tube comprises a feed tube enclosed by a heated jacket for maintaining the chemical in the feed tube at an elevated temperature.

29. A chemical handling and dispensing mechanism according to claim 10, wherein the means for sequentially loading the transfer tube with a plurality of chemical containment cartridges comprises:

(a) a rotary positioning table having a plurality of cartridge storage silos;

(b) each silo having an aperture at an upper extremity for loading chemical containment cartridges by an operator;

(c) an indexing drive mechanism connected to the rotary positioning table for sequentially positioning each silo under the transfer tube; and

(d) a loading actuator located below the silo that is positioned beneath the transfer tube for pushing a cartridge up through the silo aperture into the transfer tube where it is held by a gripping mechanism.

30. A chemical handling and dispensing mechanism according to claim 29, further comprising a mechanical interlock located at a lower extremity of each silo for inhibiting operation of the handling and dispensing mechanism if the mechanical interlock does not mate with a corresponding mechanical interlock on a cartridge in the silo.

31. A chemical handling and dispensing mechanism according to claim 29, further comprising a means for reading tagging information and electronic interlock information on the chemical cartridges in the silos.

32. A chemical handling and dispensing mechanism according to claim 31, wherein the means for reading tagging information and electronic interlock information is selected from the group consisting of a bar code reader, a magnetic strip reader, a magnetic pin reader, and an ASIC chip reader.

33. A chemical handling and dispensing mechanism according to claim 10, further comprising a means for controlling the mechanism.

34. A chemical handling and dispensing mechanism according to claim 33, wherein the means for controlling the mechanism is a programmable controller.

35. A chemical handling and dispensing method, comprising:

(a) sequentially loading a transfer tube with a plurality of chemical containment cartridges;

(b) transferring a first dispensing chamber cartridge from the transfer tube to a first dispensing chamber;

(c) transferring a second dispensing chamber cartridge from the transfer tube to a second dispensing chamber;

(d) activating a first dispensing piston positioned on a first dispensing actuator causing a chemical to be dispensed from the first dispensing chamber cartridge to a mixing mechanism;

(e) activating a second dispensing piston positioned on a second dispensing actuator causing a chemical to be dispensed from the second dispensing chamber cartridge to a mixing mechanism;

(f) ejecting the first dispensing chamber cartridge from the first dispensing chamber when the first dispensing chamber cartridge is empty; and

(g) ejecting the second dispensing chamber cartridge from the second dispensing chamber when the second dispensing chamber cartridge is empty.

36. A chemical handling and dispensing method according to claim 35, further comprising forcing a chemical through the mixing mechanism and preloading the first and second dispensing tubes by activating the first and second dispensing pistons.

37. A chemical handling and dispensing method according to claim 35, further comprising sending a warning alert to an operator if the operator fails to reload the transfer tube within a first predetermined time interval.

38. A chemical handling and dispensing method according to claim 35, further comprising shutting down the dispensing mechanism if the first and second dispensing chambers are empty and the transfer tube has not been reloaded.

39. A computer implemented method for controlling a cartridge handling and dispensing mechanism, comprising:

(a) initializing the mechanism;

(b) activating a first dispensing actuator to dispense a chemical from a first dispensing chamber cartridge in a first dispensing chamber at a controlled rate;

(c) emptying the first dispensing chamber cartridge;

(d) activating a second dispensing actuator to dispense a chemical from a second dispensing chamber cartridge in a second dispensing chamber at a controlled rate;

(e) ejecting the empty first dispensing chamber cartridge from the first dispensing chamber;

(f) loading a filled first dispensing chamber cartridge from a rotary positioning table into the first dispensing chamber;

(g) indexing the rotary positioning table;

(h) reading tagging information and electronic interlock information on a cartridge positioned beneath the transfer tube;

(i) emptying the second dispensing chamber cartridge;

(j) activating the first dispensing actuator to dispense a chemical from a first dispensing chamber cartridge in a first dispensing chamber at a controlled rate;

(k) ejecting the empty second dispensing chamber cartridge from the second dispensing chamber;

(l) loading a filled second dispensing chamber cartridge from the rotary positioning table into the second dispensing chamber;

(m) indexing a rotary positioning table;

(n) reading tagging information and electronic interlock information on a cartridge positioned beneath the transfer tube;

(o) emptying the first dispensing chamber cartridge;

(p) determining if an operator terminated operation of the handling and dispensing mechanism;

(q) determining if a supply of cartridges in the rotary positioning table is depleted;

(r) repeating steps (d) through (q) if operation of the handling and dispensing mechanism is not terminated by an operator and the supply of cartridges in the rotary positioning table is not depleted; and

(s) terminating operation of the handling and dispensing mechanism if terminated by the operator or if the supply of cartridges in the rotary positioning table is depleted.

40. A computer implemented method for controlling a cartridge handling and dispensing mechanism according to claim 39, wherein the step of initializing the mechanism comprises:

(a) loading one or more chemical cartridges into the rotary positioning table;

(b) indexing the rotary positioning table;

(c) reading tagging information and electronic interlock information on a cartridge positioned beneath the transfer tube;

(d) loading a filled first dispensing chamber cartridge from the rotary positioning table into the first dispensing chamber;

(e) indexing the rotary positioning table;

(f) reading tagging information and electronic interlock information on a cartridge positioned beneath the transfer tube;

(g) loading a filled second dispensing chamber cartridge from the rotary positioning table into the second dispensing chamber;

(h) indexing a rotary positioning table;

(i) reading tagging information and electronic interlock information on a cartridge positioned beneath the transfer tube; and

(j) purging a mixing system by activating the first and second dispensing actuators to fill a mixing mechanism with the chemical.

41. A computer implemented method for controlling a cartridge handling and dispensing mechanism according to claim 39, wherein the step of loading a dispensing chamber cartridge comprises:

(a) loading a transfer tube with a cartridge from the rotary positioning table;

(b) gripping the cartridge in the transfer tube;

(c) displacing the dispensing actuator from over the dispensing chamber;

(d) ejecting the empty dispensing chamber cartridge from the dispensing chamber;

(e) rotating the transfer tube to a position over the dispensing chamber;

(f) releasing the cartridge from the transfer tube into the dispensing chamber;

(g) rotating the transfer tube to a position over the rotary positioning table; and

(h) repositioning the dispensing actuator over the dispensing chamber.

42. A computer implemented method for controlling a cartridge handling and dispensing mechanism according to claim 39, wherein the step of determining if the supply of cartridges in the rotary positioning table is depleted comprises;

(a) determining if a number of cartridges available in the rotary positioning table is less than three after the rotary positioning table is indexed;

(b) initiating a first low chemical warning if the number of cartridges available in the rotary positioning table is equal to two after the rotary positioning table is indexed;

(c) initiating a second low chemical warning if the number of cartridges available in the rotary positioning table is equal to one after the rotary positioning table is indexed; and

(d) terminating operation of the mechanism if the number of cartridges available in the rotary positioning table is zero after the rotary positioning table is indexed, and the first and second dispensing chamber cartridges are empty.

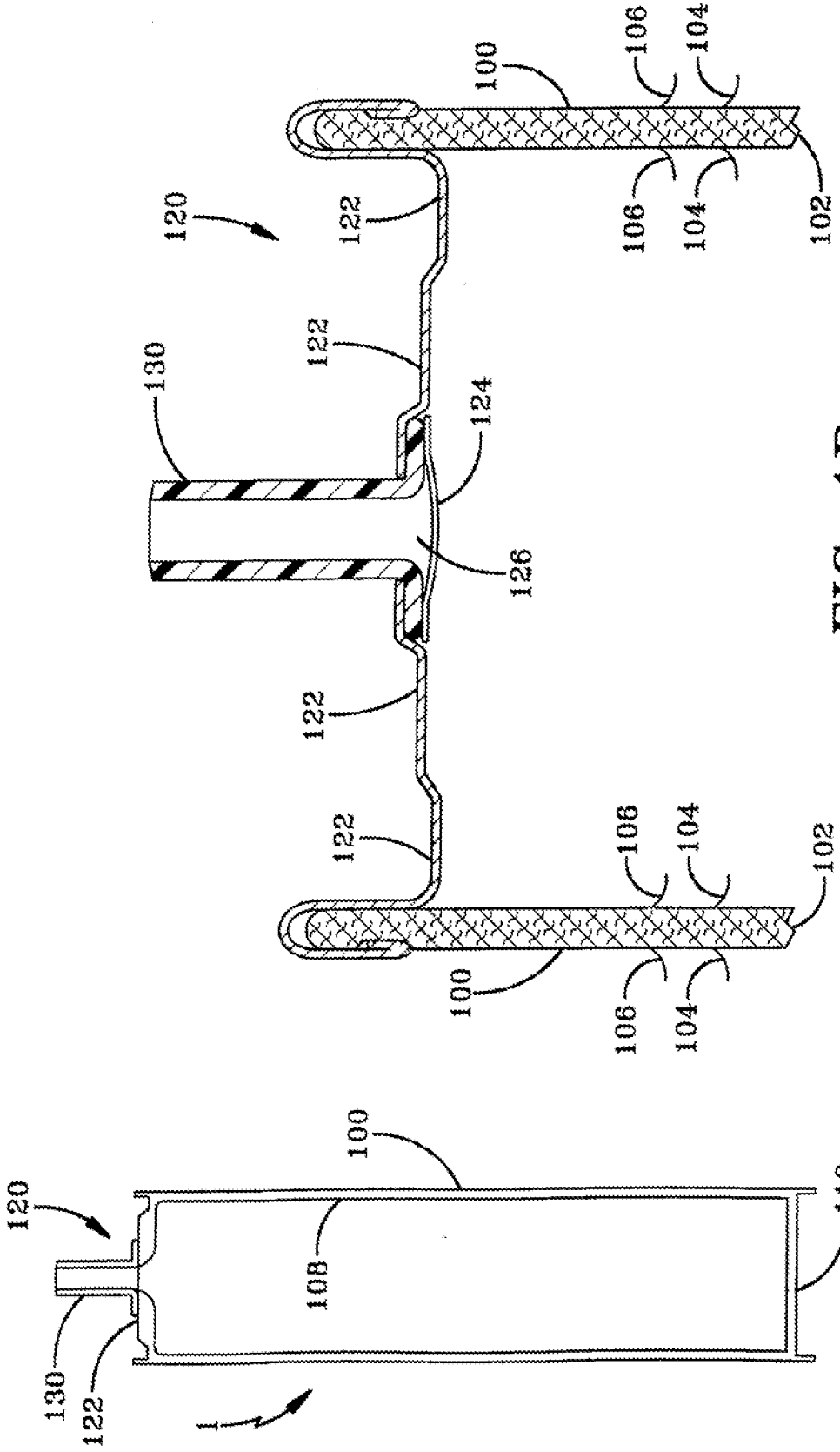


FIG-1B

FIG-1A

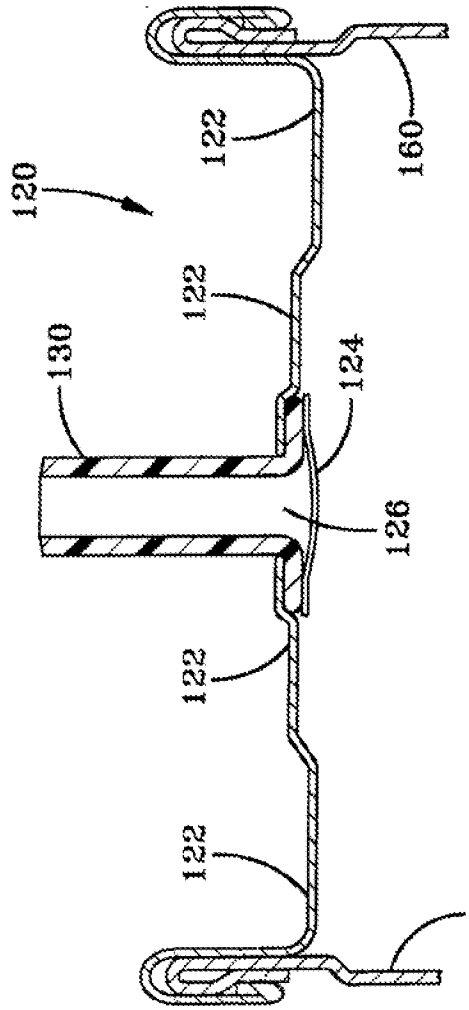


FIG-2C

FIG-2B

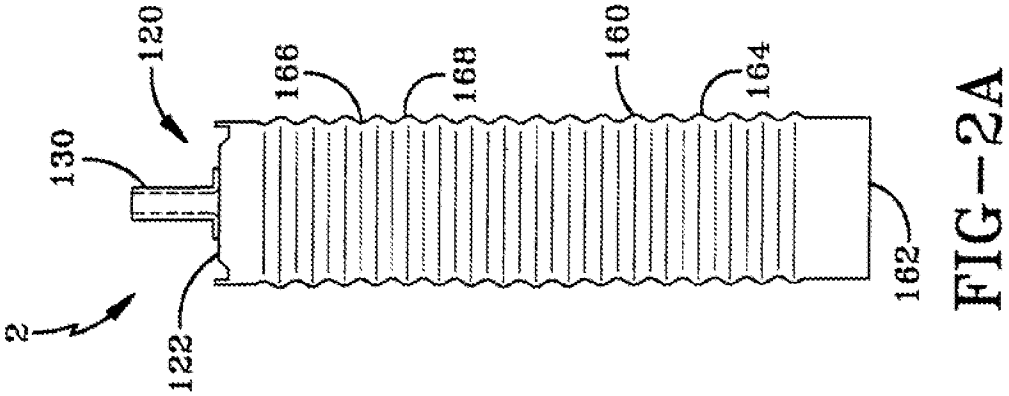
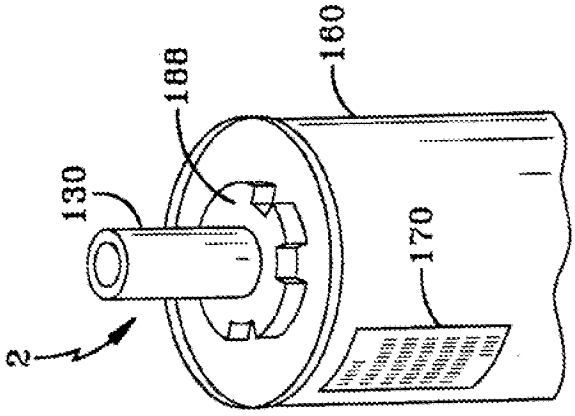
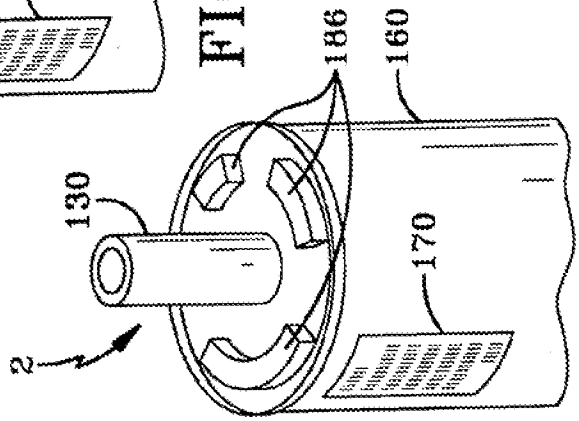


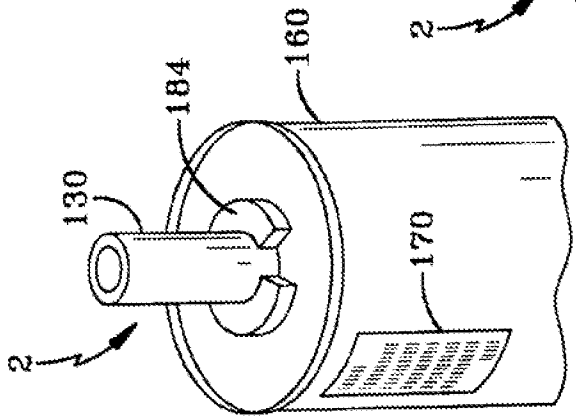
FIG-2A



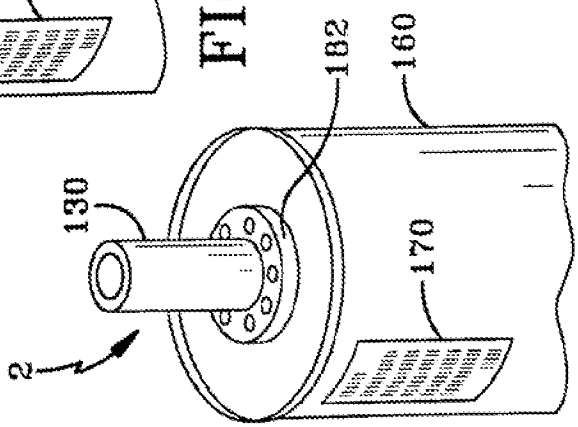
FIG–3E



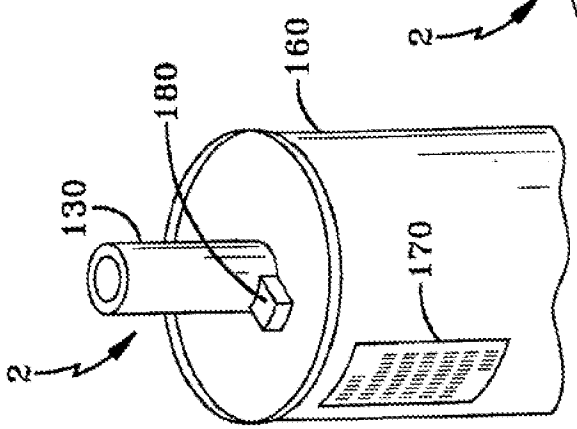
FIG–3D



FIG–3C



FIG–3B



FIG–3A

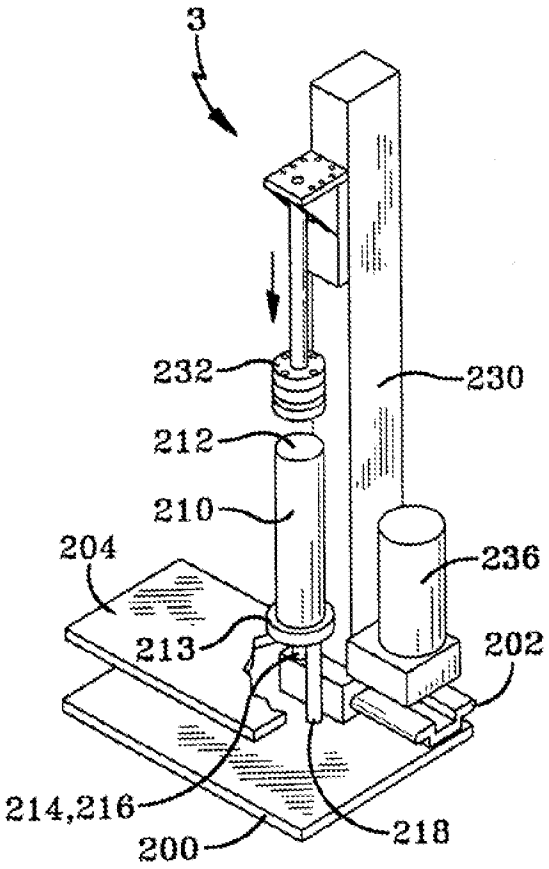

3
232
230
212
210
204
236
213
202
214,216
218
200

FIG-4A

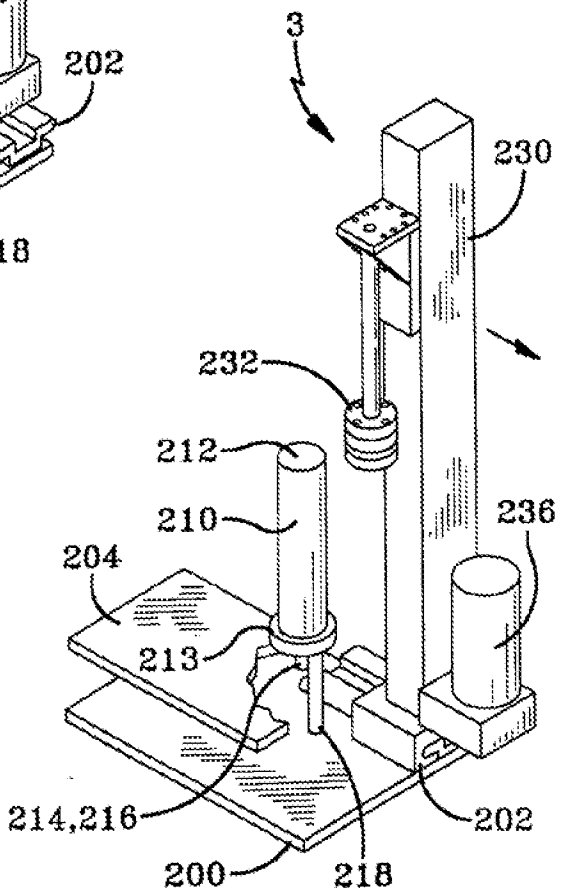

3
230
232
212
210
236
204
213
214,216
202
200
218

FIG-4B

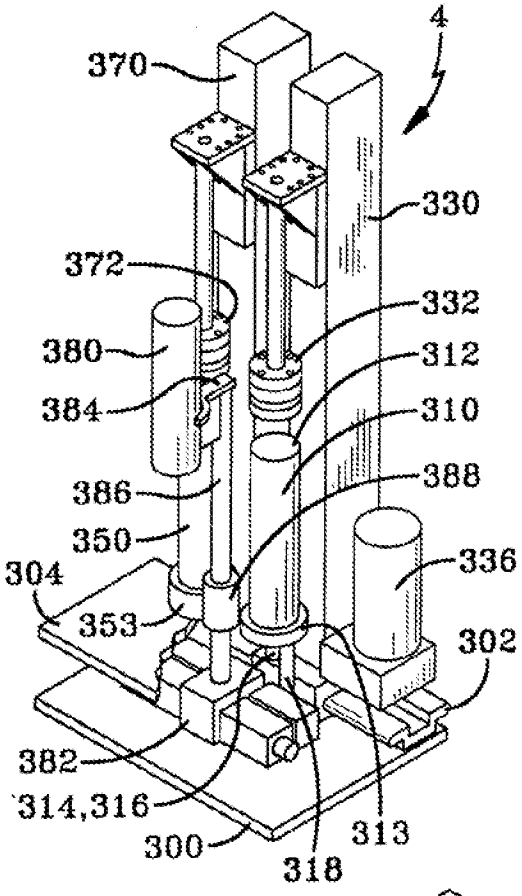


FIG-5A

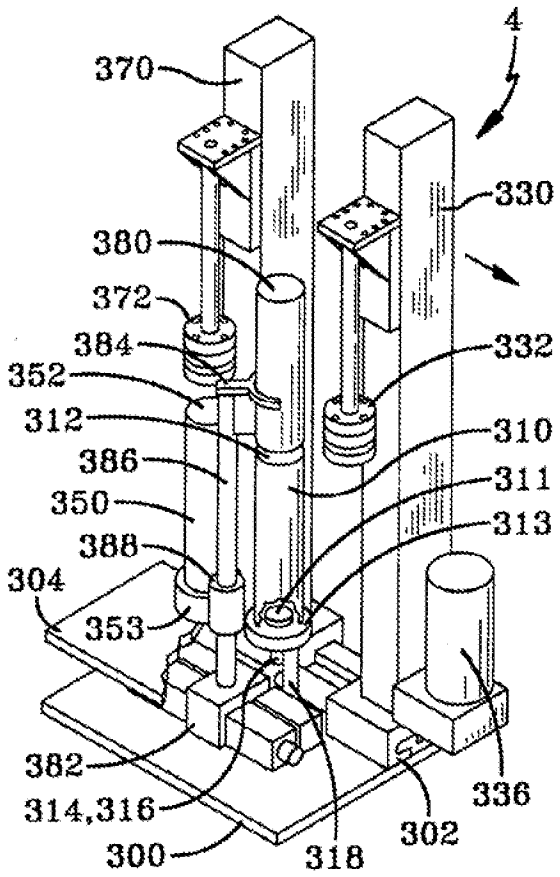


FIG-5B

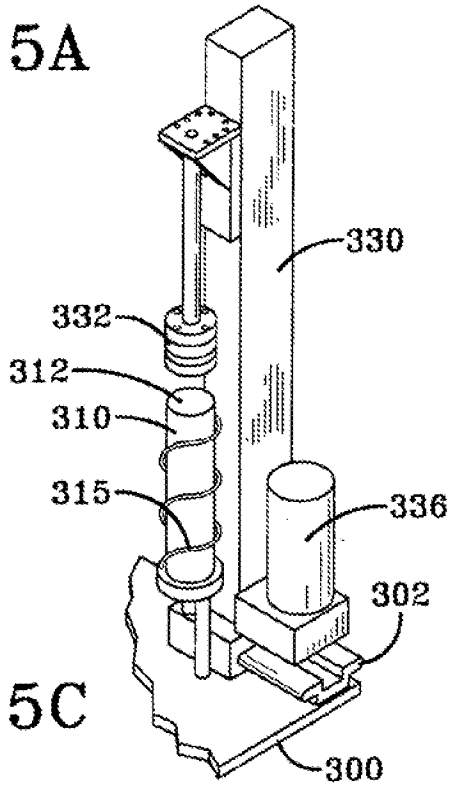


FIG-5C

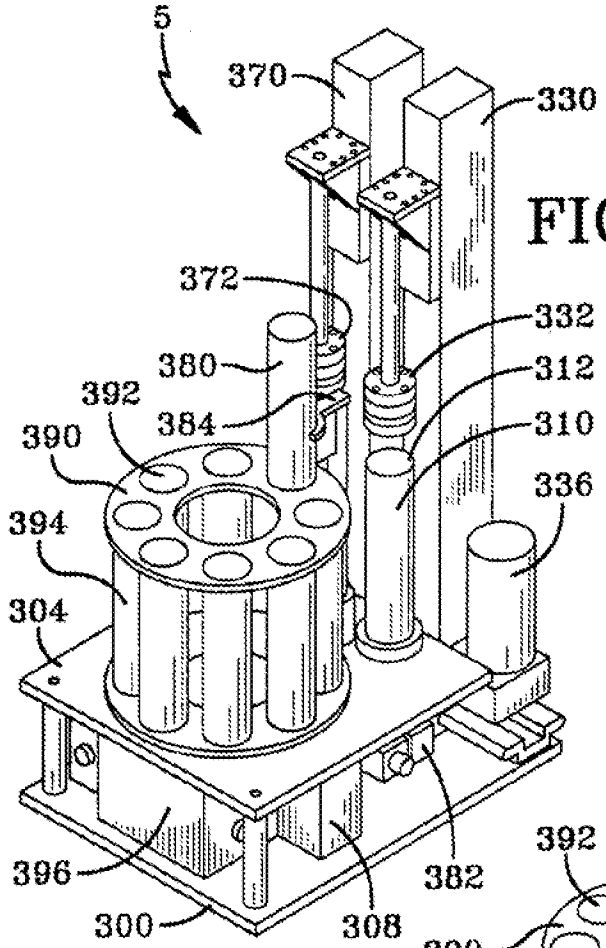


FIG-6A

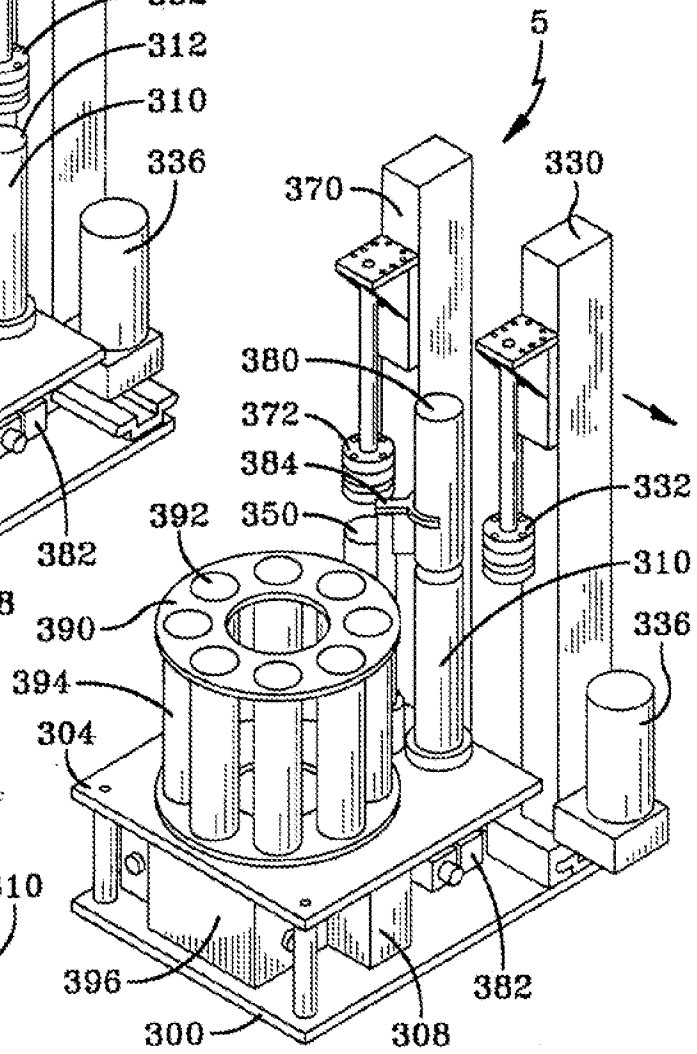


FIG-6B

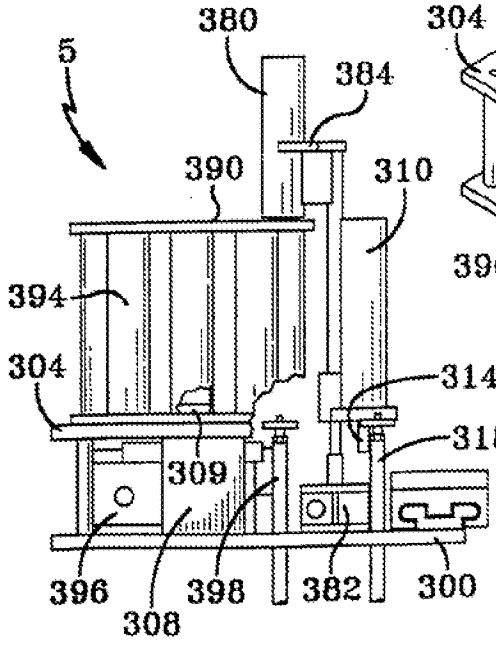
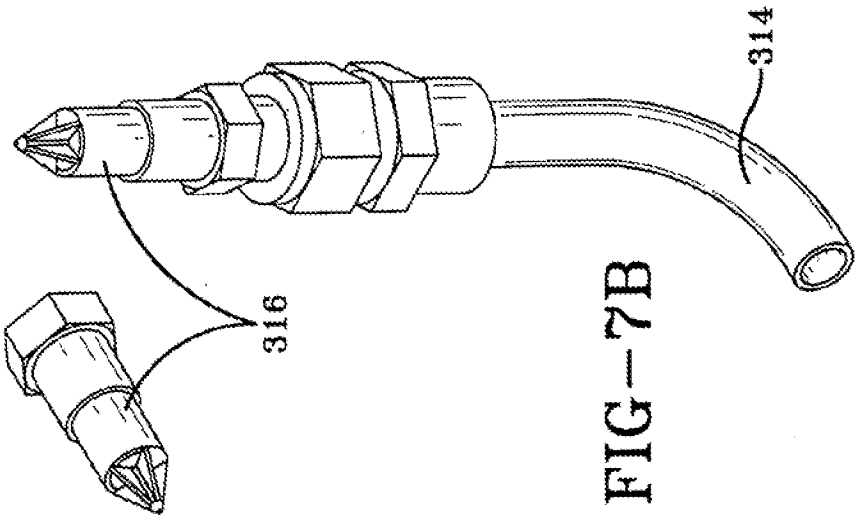
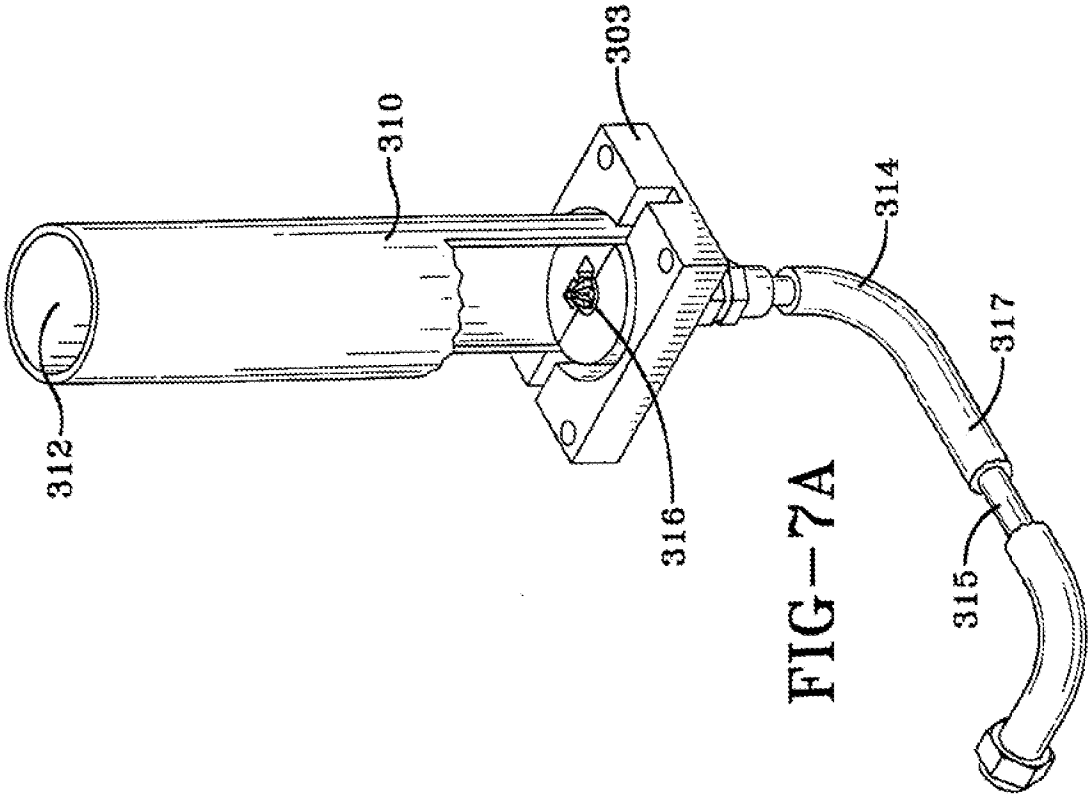


FIG-6C



FIG–7B



FIG–7A

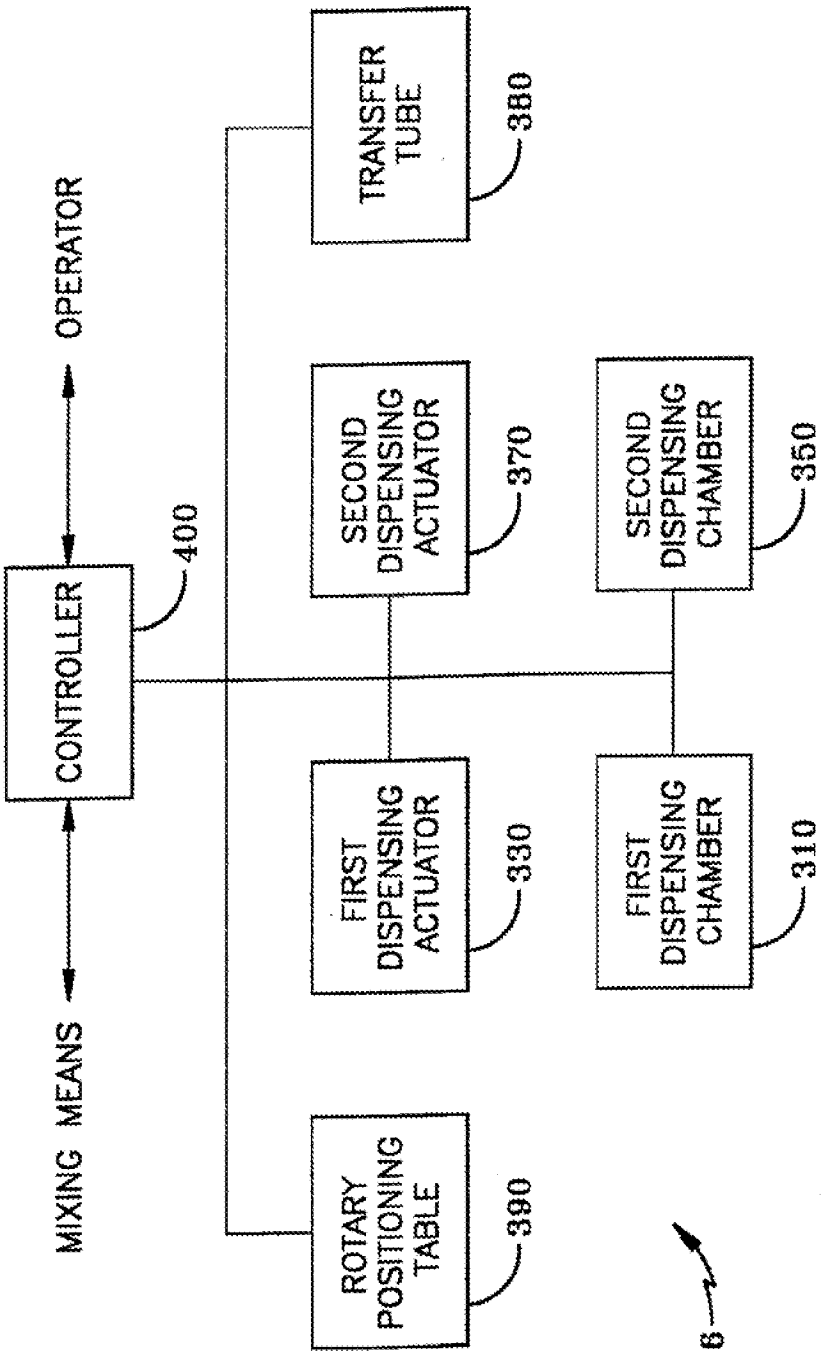

OPERATOR
CONTROLLER
400
MIXING MEANS
TRANSFER TUBE
380
SECOND DISPENSING ACTUATOR
370
SECOND DISPENSING CHAMBER
350
FIRST DISPENSING ACTUATOR
330
FIRST DISPENSING CHAMBER
310
ROTARY POSITIONING TABLE
390
8

FIG-8

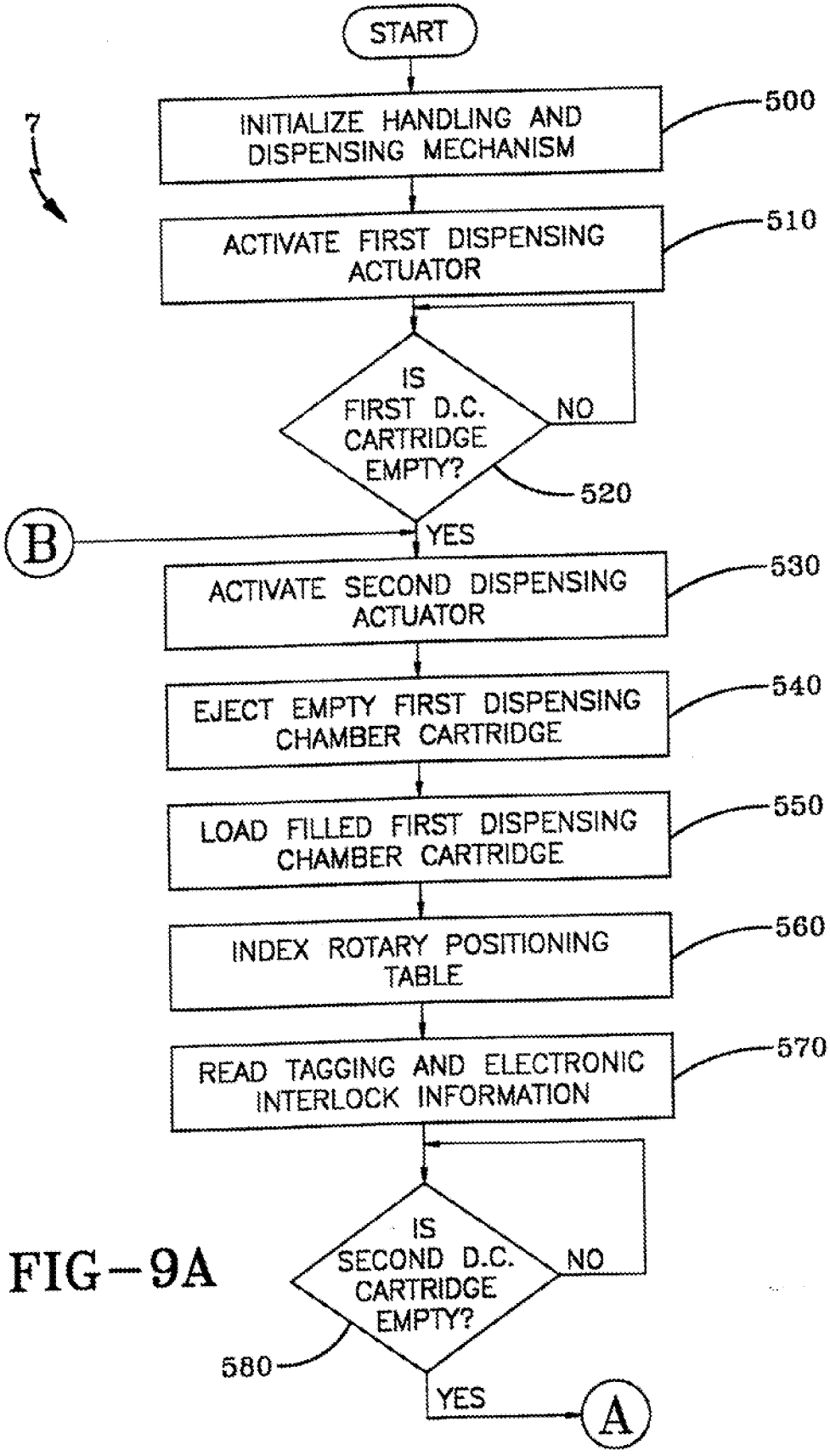

START
7
INITIALIZE HANDLING AND DISPENSING MECHANISM
500
ACTIVATE FIRST DISPENSING ACTUATOR
510
IS FIRST D.C. CARTRIDGE EMPTY?
NO
520
YES
B
ACTIVATE SECOND DISPENSING ACTUATOR
530
EJECT EMPTY FIRST DISPENSING CHAMBER CARTRIDGE
540
LOAD FILLED FIRST DISPENSING CHAMBER CARTRIDGE
550
INDEX ROTARY POSITIONING TABLE
560
READ TAGGING AND ELECTRONIC INTERLOCK INFORMATION
570
IS SECOND D.C. CARTRIDGE EMPTY?
NO
580
YES
A

FIG-9A

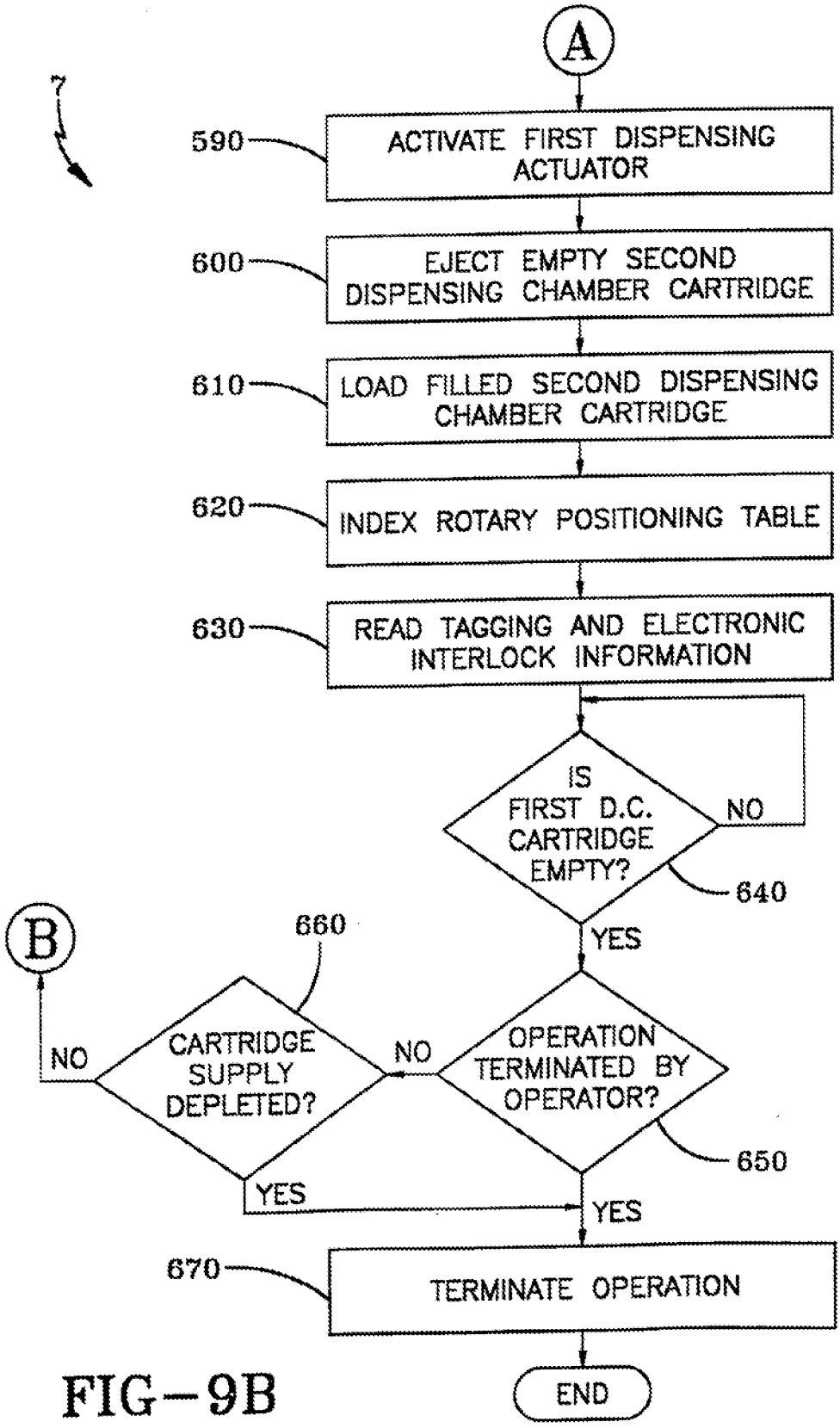
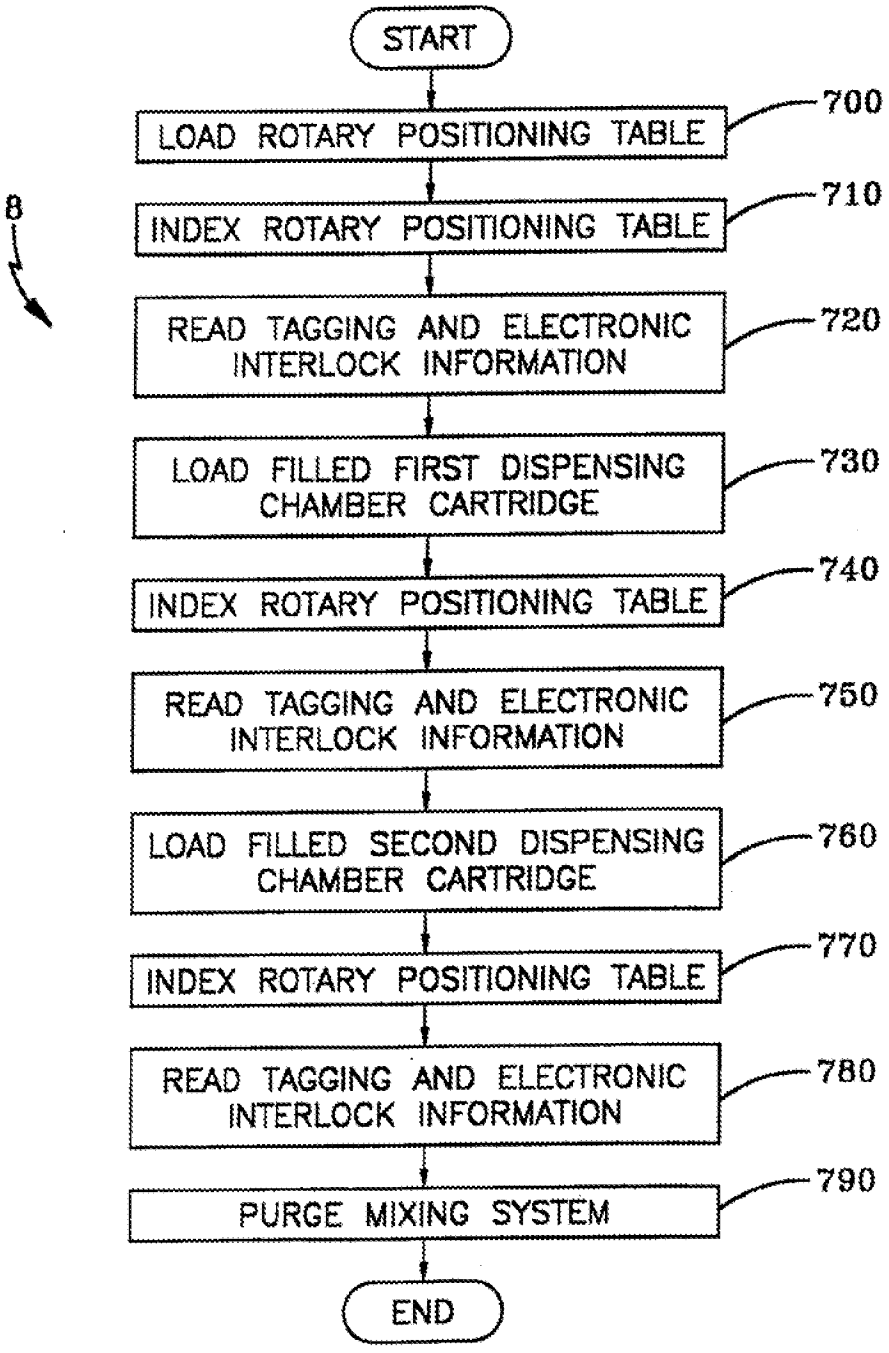

A
7
590
ACTIVATE FIRST DISPENSING ACTUATOR
600
EJECT EMPTY SECOND DISPENSING CHAMBER CARTRIDGE
610
LOAD FILLED SECOND DISPENSING CHAMBER CARTRIDGE
620
INDEX ROTARY POSITIONING TABLE
630
READ TAGGING AND ELECTRONIC INTERLOCK INFORMATION
IS FIRST D.C. CARTRIDGE EMPTY?
NO
640
YES
B
660
NO
CARTRIDGE SUPPLY DEPLETED?
NO
OPERATION TERMINATED BY OPERATOR?
650
YES
YES
670
TERMINATE OPERATION
END

FIG-9B


START
LOAD ROTARY POSITIONING TABLE
700
8
INDEX ROTARY POSITIONING TABLE
710
READ TAGGING AND ELECTRONIC INTERLOCK INFORMATION
720
LOAD FILLED FIRST DISPENSING CHAMBER CARTRIDGE
730
INDEX ROTARY POSITIONING TABLE
740
READ TAGGING AND ELECTRONIC INTERLOCK INFORMATION
750
LOAD FILLED SECOND DISPENSING CHAMBER CARTRIDGE
760
INDEX ROTARY POSITIONING TABLE
770
READ TAGGING AND ELECTRONIC INTERLOCK INFORMATION
780
PURGE MIXING SYSTEM
790
END

FIG–10

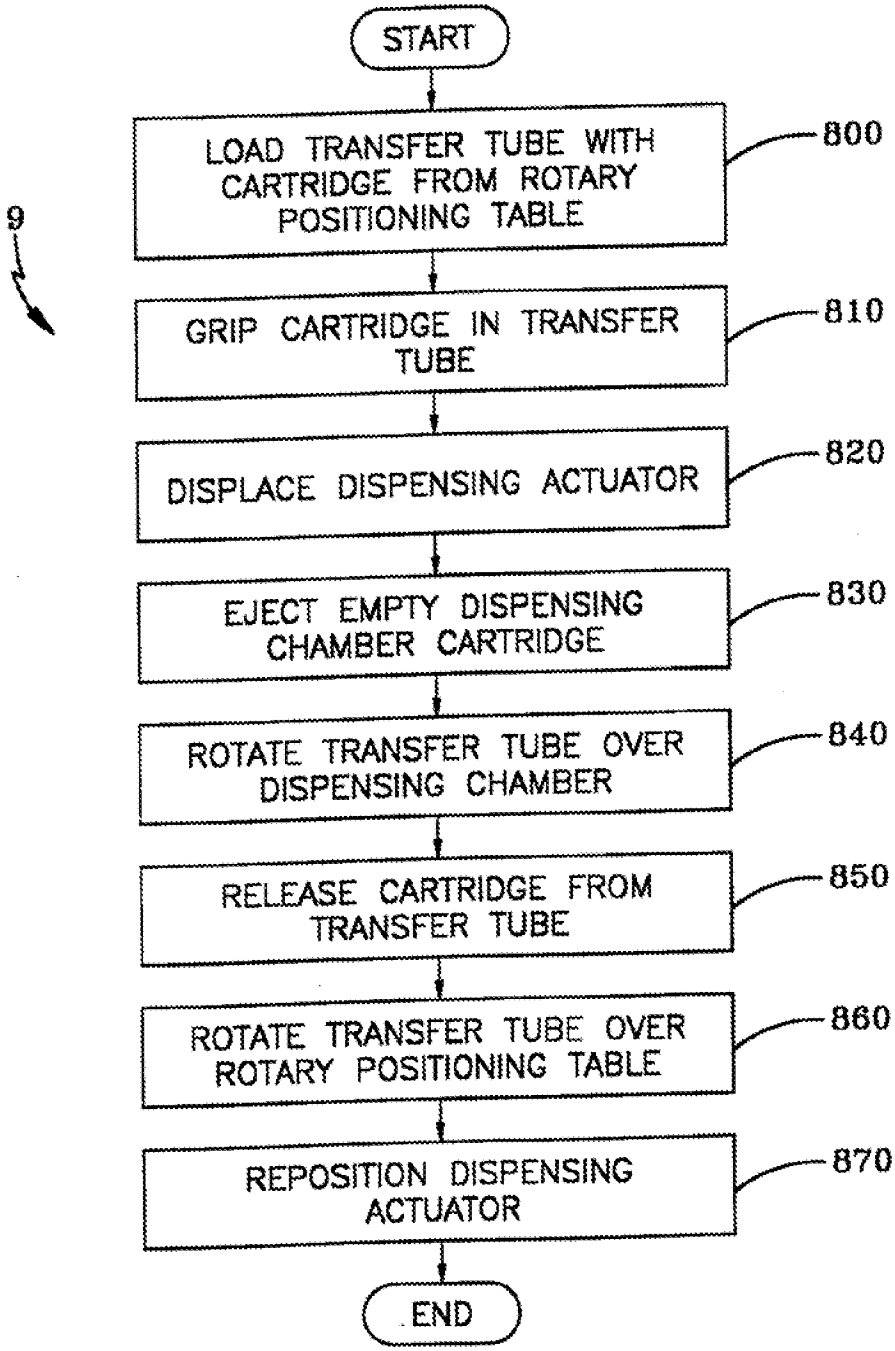

START
LOAD TRANSFER TUBE WITH CARTRIDGE FROM ROTARY POSITIONING TABLE
800
9
GRIP CARTRIDGE IN TRANSFER TUBE
810
DISPLACE DISPENSING ACTUATOR
820
EJECT EMPTY DISPENSING CHAMBER CARTRIDGE
830
ROTATE TRANSFER TUBE OVER DISPENSING CHAMBER
840
RELEASE CARTRIDGE FROM TRANSFER TUBE
850
ROTATE TRANSFER TUBE OVER ROTARY POSITIONING TABLE
860
REPOSITION DISPENSING ACTUATOR
870
END

FIG-11

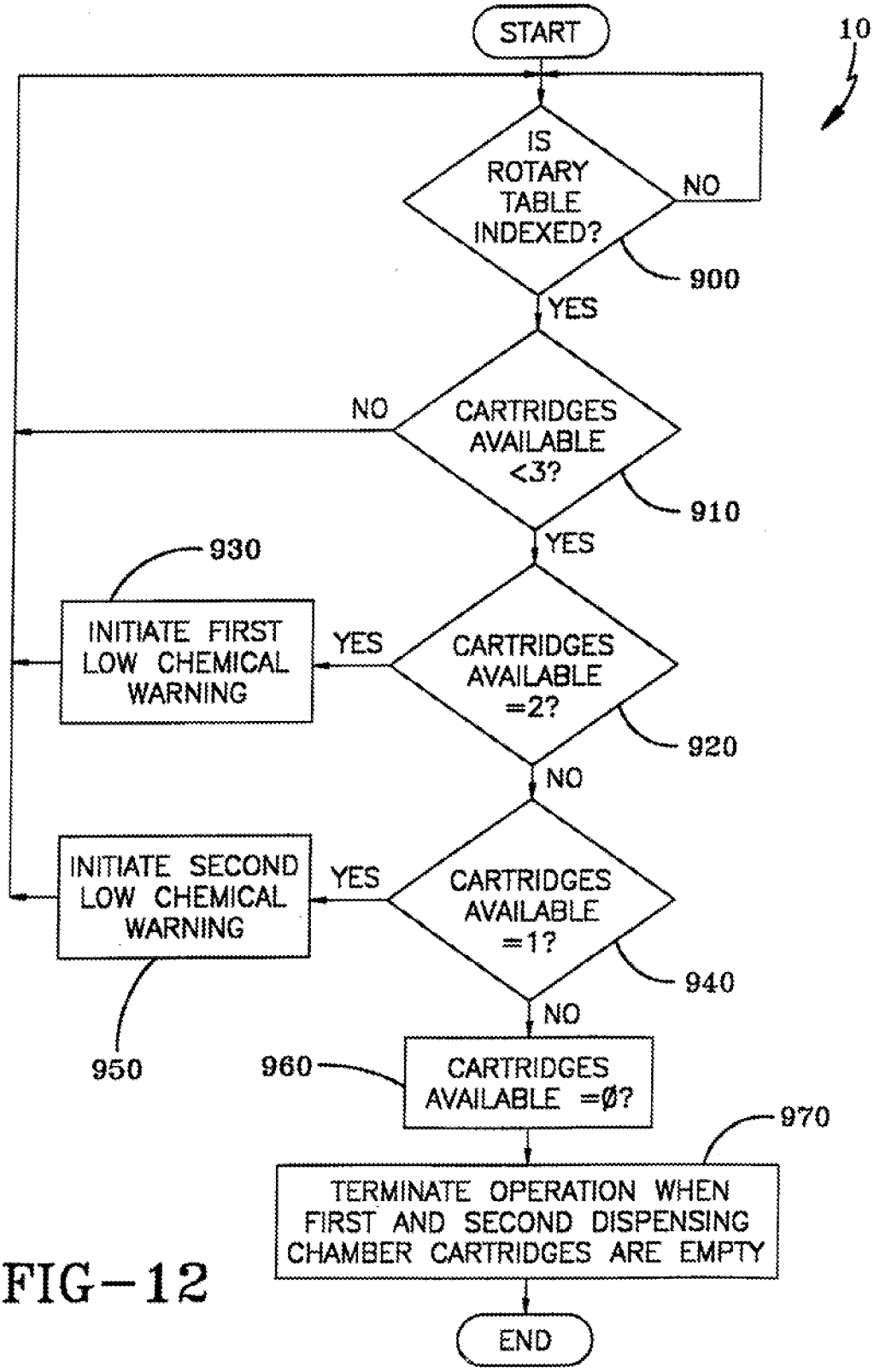

START
10
IS ROTARY TABLE INDEXED?
NO
900
YES
CARTRIDGES AVAILABLE <3?
NO
910
YES
930
INITIATE FIRST LOW CHEMICAL WARNING
YES
CARTRIDGES AVAILABLE =2?
920
NO
INITIATE SECOND LOW CHEMICAL WARNING
YES
CARTRIDGES AVAILABLE =1?
940
NO
950
960
CARTRIDGES AVAILABLE =Ø?
970
TERMINATE OPERATION WHEN FIRST AND SECOND DISPENSING CHAMBER CARTRIDGES ARE EMPTY
END

FIG-12

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US99/26766

A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) :B67D 5/00
US CL :222/82

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 222/82, 144, 146.5, 160, 168, 168.5, 326, 327, 386; 141/329, 330

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X --- A	US 4,420,508 A (GIBSON) 13 December 1983 (13.12.83), see entire document.	1, 5, 7 --- 2, 4, 6, 8, 11-13, 16-21, 23-32, 34-42
X --- Y	US 5,184,757 A (GIANNUZZI) 09 February 1993 (09.02.93), see entire document.	1, 3, 5, 7, 9, 10, 14, 22, 33 --- 15

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

*	Special categories of cited documents:	"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A"	document defining the general state of the art which is not considered to be of particular relevance	"X"	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E"	earlier document published on or after the international filing date	"Y"	document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"L"	document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&"	document member of the same patent family
"O"	document referring to an oral disclosure, use, exhibition or other means		
"P"	document published prior to the international filing date but later than the priority date claimed		

Date of the actual completion of the international search 23 FEBRUARY 2000	Date of mailing of the international search report 11APR2000
Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703) 305-3230	Authorized officer ANDRES KASHNIKOW Telephone No. (703) 308-1148

Form PCT/ISA/210 (second sheet)(July 1992)*